PROCEEDINGS
OF THE
CALIFORNIA ACADEMY OF SCIENCES

Vol. 42, No. 16, pp. 409–433, 2 figs., 9 tables

October 26, 1981

FOOD HABITS OF SMALLER MARINE MAMMALS FROM NORTHERN CALIFORNIA

By

Robert E. Jones

Museum of Vertebrate Zoology, University of California, Berkeley, California 94720

ABSTRACT: General food habits are discussed for 11 species of small marine mammals beach-cast in northern California. The collection method allowed tabulation only of the kinds, numbers, and percentages of fish, molluscan, and crustacean prey.

Dominant food species for all male *Zalophus californianus* were the following: *Merluccius productus* (62.8 percent of occurrence), *Engraulis mordax* (23.8 percent), Scorpaenidae (6.3 percent), *Porichthys notatus* (3.2 percent). *Octopus* and *Loligo* also occurred in 7 (23.0 percent) of 30 California sea lions examined.

Nine of 19 individuals of *Eumetopias jubatus* contained food remnants of fish; 10 new dietary items are reported. Seven of the nine also fed on invertebrates, including four kinds of cephalopods. Scorpaenidae 31.2 percent of occurrence), *Merluccius productus* (21.7 percent), Pleuronectidae (17.3 percent), and *Chilara taylori* (11.8 percent) were the principal fishes identified.

Eight of 12 *Phoca vitulina* stomachs contained food (6 with fish, 2 with invertebrates). Embiotocids (41.9 percent of occurrence), *Lycodopsis pacifica* (27.9 percent), Pleuronectidae (9.3 percent), and *Hexagrammos decagrammus* (9.3 percent) were the dominant fishes. The only cephalopod identified from *Phoca* was *Octopus*.

The stomachs of all seven individuals of *Lagenorhynchus obliquidens* examined contained food. Osmerid fishes, *Porichthys*, and juvenile rockfishes were the most frequent items identified. The presence of five genera of cephalopods suggests that *Lagenorhynchus* can take a wide variety of prey from several habitats.

Juvenile Scorpaenidae, *Engraulis*, *Merluccius*, and *Microgadus* made up 97 percent of the diet of 20 individuals of *Phocoena phocoena*. The abundant cephalopod *Loligo* was a primary invertebrate food item and was ingested whole.

INTRODUCTION

The objective of this study is to summarize the literature on the diets of smaller marine mammals in the eastern Pacific and to report on the contents of 102 stomachs from five pinniped and six small cetacean species. The purpose has been to make a thorough scrutiny of published dietary knowledge and analyze stomachs of beach-cast specimens. Particular attention has been directed to reviewing all records on feeding controversy. It has been argued for many decades that marine mammals compete with commercial fishing industries (Anonymous 1901; Townsend 1918).

Marine biologists in California have questioned the impact of marine mammals on the state's fisheries for at least 100 years (Redding et al. 1875; Rutter et al. 1904; California Division of Fish and Game 1927; Hedgpeth 1944; Anderson 1960; Frey 1971; National Oceanic and Atmospheric Administration 1974). The report of the California Commissioners of Fisheries for the years 1874–1875 (Redding et al. 1875) stated clearly that sea lions and seals were protected by special enactment, with penalties imposed on any person who should kill or disturb the beasts. On the basis of the observed "hundred-fold" increase in the populations of seals and sea lions at the entrance to San Francisco Bay over the previous ten-year period, the Commissioners recommended the killing of nine-tenths of the existing population. It is unclear as to what action, if any, resulted from this recommendation. Scammon (1874) stated, "A few years ago great numbers of sea lions were taken along the coast of Upper and Lower California, and thousands of barrels of their oil were obtained." The statement describes the period before the enactment of regulations protecting California pinnipeds. On the west coast of North America, most of the commercial seal and sea-lion killing stopped about 1860 (Bonnot 1928).

The problem of a declining fishery was aired before another commission at San Francisco in 1899, and on 27 April 1899, permission was granted to kill sea lions along the coast, including lighthouse reservations (Bonnot 1928). The data from stomach inspections, gathered by Professor L. L. Dyche in 1899, were published by C. H. Merriam (1901a, 1901b). These publications were an attempt toward a critical examination of stomachs from slaughtered sea lions. A view held by many was that stomach analysis was utterly useless, for the observed fact was that sea lions pursued salmon through the Golden Gate as far as Sacramento (Anonymous 1901). Thousands were killed before the Treasury Department prohibited wholesale slaughter on government lands on 31 May 1899 (Merriam 1901a). The destruction of sea lions was justified by the belief that the declining shad (*Alosa sapidissima*), salmon (*Oncorhynchus* spp.), and striped bass (*Morone saxatilis*) fisheries would thereby increase, but little evidence was gathered to verify or deny such claims. The U.S. Fish Commission, the Secretary of the U.S. Department of Agriculture, and the New York Zoological Society opposed the decisions of the California Fish Commission (Anonymous ["Steelhead" pseudonym] 1901).

The controversy over control of sea lion populations pitted biologists C. Hart Merriam, Barton W. Evermann, and William T. Hornaday against David Starr Jordan, Charles H. Gilbert, Harvey W. Harkness, and N. Baird Scofield (Starks 1918; Townsend 1918, 1919). The 1904 report of a Federal commission appointed to review the situation contains the first published list of stomach contents of a series of California sea lions (*Zalophus*) and northern sea lions (*Eumetopias*) (Rutter et al. 1904).

In 1914–1916, the Newcombe Commission gathered basic biological field data in British Columbia (Newcombe and Newcombe 1914; Newcombe et al. 1918). Twelve of the 14 northern sea lions examined contained intact herring; however, food items consumed by these sea lions throughout the year were not documented.

Early in the 20th century, suggestions were made to harvest young sea lions, following the example of the Newfoundland harp-seal industry. Harp seals (*Phoca*) had been cropped annually for 100 years with an annual take of pups exceeding 200,000. Recommendations for control of pinnipeds in California gained the support of many prominent biologists (Townsend 1919).

Following an investigation at the lighthouse reservation on Año Nuevo Island (Evermann 1921), it was stated that surplus bulls on this rookery could be killed (Evermann and Hanna 1925). This is the earliest example of a recommendation to harvest marine mammals along the California coast based on biological information. Because sea lions and seals are polygamous, it was felt that 10 percent of the excess males could be killed, but for economic reasons the cropping was not carried out (Rowley 1929). Target clubs obtained military surplus guns and ammunition and "practiced" on the Santa Cruz and San Mateo coast pinniped populations. Apparently this activity frightened the pinnipeds enough to cause their departure (Herb Steindorf, local rancher, pers. comm., 1969). Fishermen still ask permission to kill sea lions, and numerous reports of damage to the fishery continue to this day.

Between the late 1920's and 1972, when the Marine Mammal Protection Act was passed, certain marine mammals were fully protected, but commercial and sport fishermen (actively fishing from boats) could kill sea lions and harbor seals interfering with their operations (California Fish and Game Code, Sections 3002, 4500). Thus fishermen could protect their nets, tackle, and fish from damage by marine mammals. The California Fish and Game Commission reserved the right to reduce the population and to require permits for educational display or scientific taking of sea lions or seals. The sea otter (*Enhydra lutris*), Guadalupe fur seal (*Arctocephalus townsendi*), and elephant seal (*Mirounga angustirostris*) were fully protected. State laws applied only to the seals, sea lions, and sea otter; no regulations concerning cetaceans were in effect until the enactment of the Marine Mammal Protection Act of 1972. This protection placed an immediate moratorium upon the taking and importation of all marine-mammal products into the United States (National Oceanic and Atmospheric Administration 1974). The oft-repeated complaint about the lack of life history data on most of our common species of marine mammals is still valid (Starks 1918; Anderson 1960; Peterson and Bartholomew 1967; Briggs and Davis 1972). Even the age at puberty and physical maturity of the California sea lion (*Zalophus californianus*) is unknown (Harrison 1972). There are few published accounts of marine mammal life histories, and these studies seldom contain precise information on food habits (Bartholomew 1967; Orr and Poulter 1965, 1967; Peterson and Bartholomew 1967; Peterson and LeBoeuf 1969; Odell 1971; Seed 1972). General publications on marine mammals seldom contain significant or specific information on food habits (Sergeant and Fisher 1957; Slijper 1962; King 1964; Evans and Bastian 1969; Daugherty 1972; Orr 1972; Ridgway 1972).

Notes on food habits of pinnipeds have been reported in the literature since the early work of L. L. Dyche in 1903 (Bonnot 1928, 1932a, 1932b, 1951; Scheffer and Neff 1948; Scheffer 1950a; Mathisen 1959; Mathisen et al. 1962; Thorsteinson and Lensink 1962; Fiscus and Baines 1966; Morejohn and Baltz 1970; Briggs and Davis 1972).

The literature on distribution, food habits, and life histories of small cetaceans is less extensive, and wholly inadequate. While the federal status report to the Secretary of Commerce (National Oceanic and Atmospheric Administration 1974) is the most complete summary of studies to date, natural history data are lacking even for the most common species. Cetaceans have not had a reputation for eating commercially important fishes nor for harassing fishermen. Until 1972 there were no federal laws protecting or regulating the capture of small whales or porpoises. Recently large numbers of porpoises have been killed during tuna-fishing operations (Perrin 1970). Papers dealing with food habits of cetaceans are widely scattered (Scheffer 1950b, 1953; Brown and Norris 1956; Tomilin 1957; Wilke and Kenyon 1952, 1957; Wilke and Nicholson 1958; Norris and Prescott 1961; Fitch and Brownell 1968; Loeb 1972; Perrin et al. 1973).

More study is needed on feeding rates and feeding phenomena (Sergeant 1968, 1969). Fasting periods and basic metabolic rates obviously affect calculations of the impact of marine mammals on the food resources of the sea. The role of marine mammals in overall ocean ecology needs further study. Current knowledge of food chains and trophic relationships of marine mammals has only recently been given attention by marine ecologists (Steele 1970).

Materials and Methods

During this study, I examined 102 specimens found dead on California beaches (Table 1). The 11 species of marine mammals studied (Figures 1 and 2) include two phocids, *Mirounga angustirostris* and *Phoca vitulina*, and three otariids, *Eumetopias jubatus*, *Zalophus californianus*, and *Callorhinus ursinus*. The six cetacean species represent three families: Phocoenidae, *Phocoena phocoena* and *Phocoenoides dalli*; Delphinidae, *Delphinus delphis*, *Grampus griseus*, and *Lagenorhynchus obliquidens*; and Physeteridae, *Kogia simus*.

Where feasible, specimens up to about 100 pounds (45 kg) were removed to the laboratory and data were recorded on standardized sheets (Norris 1961; Scheffer 1967). Where terrain or tidal conditions did not allow removal, carcasses were measured in place. All possible standard measurements were taken.

The skull, baculum (when present), and stomach were collected from specimens too large to move. All material was labeled and taken to the laboratory for careful examination. Osteological material from each specimen was tagged and cleaned by standard museum techniques. Thirteen stomachs were donated by personnel of the California Academy of Sciences.

After initial external cleaning, 25 stomachs were filled with cool tap water and measured to obtain an average stomach volume (Table 2). Each water-filled stomach was drained of its

TABLE 1. NUMBER OF MARINE MAMMAL STOMACHS EXAMINED IN NORTH-CENTRAL CALIFORNIA, 1968–1973; (n = 102). A total of 68 stomachs contained food items; of these, 61 had fish remains, 33 invertebrates.

CETACEANS	*Phocoena*	*Phocoe-noides*	*Lagenorhyn-chus*	*Delphinus*	*Grampus*	*Kogia*	Total
Examined	20	5	7	1	1	1	35
With contents	16	2	7	1	1	1	28
Empty	4	3	0	0	0	0	7
With fish	14	2	5	1	0	1	23
With invertebrates	8	0	3	1	1	1	14
PINNIPEDS	*Zalophus*	*Eumetopias*	*Phoca*	*Callorhinus*	*Mirounga*		Total
Examined	30	19	12	4	2		67
With contents	20	9	8	1	2		40
Empty	10	10	4	3	0		27
With fish	20	9	6	1	2		38
With invertebrates	7	7	2	2	0		19
With rock or plant material	1	3	0	0	0		4

contents into a graduated cylinder for accurate volumetric reading.

Stomach contents were segregated, using a parasite-recovery technique of flotation and decanting, and then washed repeatedly with clean water. This method of sedimentation-decantation allows speedy recovery of all items. Small otoliths (lapilli) were occasionally detected, but all otoliths reported here were sagittae. Other workers (Fitch and Brownell 1968; Morejohn and Baltz 1970; Smith and Gaskin 1974) have screened gastro-intestinal materials through cheesecloth gauze or graded wire screens.

Disarticulated bones were separated from internal parasites with forceps. Fish bones and otoliths were dried overnight. Soft tissues were preserved in alcohol.

The heavy fish otoliths (sagittae) were easily seen by moving the clear glass container over backgrounds of several different colors. Even the tiny otoliths (asterisci or lapilli) could be detected when they were gently moved by the covering water. I removed the otoliths with a camel hair brush or fine forceps. They were carefully cleaned of mucus (film), dried, and stored in gelatin pill containers. John E. Fitch, California Department of Fish and Game, provided identifications.

Most cephalopod beaks, which were stored in alcohol, were identified using the pictorial guide developed by the California Department of Fish and Game (Iverson and Pinkas 1971). Several types were identified by Clifford Fiscus, National Marine Mammal Laboratories, U.S. Department of Commerce. I later checked these samples using the keys developed by Clarke (1962) and by comparing them with squid beaks furnished by Jerome L. Spratt of the California Department of Fish and Game. Four hundred thirty-five cephalopod beaks and 2828 fish otoliths were identified. Thirty-one otoliths and 217 cephalopod beaks were not identifiable. I was able to identify most cephalopod beaks only to genus.

Few stomachs contained intact fish. Fish skeletal material was air-dried, and its volume was measured in a graduated cylinder (Table 9). Fish remains were identified with the aid of Clothier 1950; Roedel 1953; Clemens and Wilby 1961; Fitch and Lavenberg 1971; and Miller and Lea 1972. Common names used follow those of the American Fisheries Society (Robins et al. 1980) except for Atka-mackerel and jackmackerel, which follow Hubbs, Follett, and Dempster (1979). All recovered materials (specimens and contents) are deposited in the Museum of Vertebrate Zoology, Berkeley, or the California Academy of Sciences, San Francisco.

A total of 35 cetacean and 67 pinniped carcasses was beach-cast along north-central California. Voucher material has been collected and deposited at these institutions: CAS, California Academy of Sciences, San Francisco; MVZ, Museum of Vertebrate Zoology, University of California, Berkeley; HSC, Humboldt State University, Vertebrate Zoology Museum, Arcata; PORE, Point Reyes National Seashore, Point Reyes.

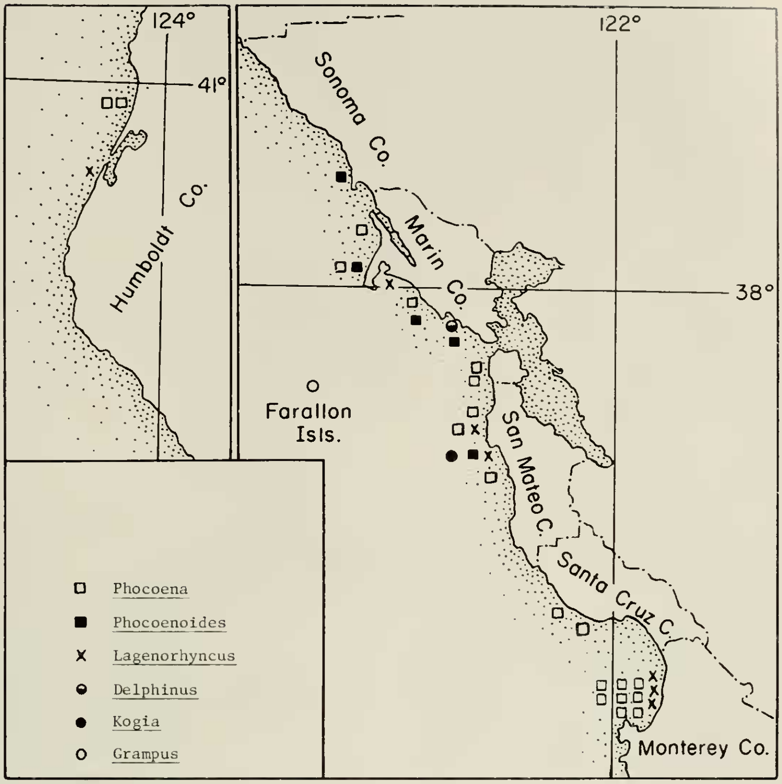

FIGURE 1. Localities of cetacean beach-cast specimens in north-coastal California, 1968–1973.

CETACEAN

Humboldt Co.—*Phocoena*: HSC 68-7, F, 2 Sep. 1968, 122 cm, 12 otoliths; HSC 73-4, M, 21 Aug. 1973, 150 cm est., 14 otoliths.—*Lagenorhynchus*: HSC 68-9, M, 26 Dec. 1968, 179 cm, 36 otoliths, 1 cephalopod beak.

Sonoma Co.—*Phocoenoides*: MVZ 153258 (REJ 670), F, 28 June 1973, 102 cm, empty.

Marin Co.—*Phocoena*: CAS 16602 (2385), M, 1 June 1973, 138 cm, 1083 otoliths; CAS 16603 (2385), 1 June 1973, 146 cm, empty; CAS 21380 (REJ 448), F, 3 July 1970, 158 cm, 15 otoliths.—*Phocoenoides*: MVZ 153259 (REJ 678), F, 7 Aug. 1973, 186 cm, empty; CAS 16604 (2385), M, 1 June 1973, 198 cm, empty; CAS 16297 (2335), M, 21 Sep. 1972, 188 cm, 6 otoliths.—*Lagenorhynchus*: MVZ 140845 (REJ 218), F, 9 Feb. 1970, 181 cm, no ID.—*Delphinus*: CAS 16242 (2340), F, 6 Nov. 1972, 168 cm, 11 otoliths, 4 cephalopod beaks.

San Francisco Co.—*Phocoena*: CAS 16629 (2384), M, 26 May 1973, 140 cm, 2 otoliths; CAS 16572 (2398), F, 20 Aug. 1973, 137 cm, 17 otoliths.—*Grampus*: MVZ 153257 (REJ 659), F, 20 May 1973, 275 cm, barnacle and hydroid.

San Mateo Co.—*Phocoena*: CAS 15992 (2237), F, 19 July 1971, 143 cm, 33 otoliths; CAS 16609 (2390), F, 13 July 1973, 159 cm, 26 otoliths and 1 hake; CAS 16633 (2392), F, 13 July 1973, 126 cm, 4 otoliths, 35 pair cephalopod beaks and 13 whole *Loligo*.—*Phocoenoides*: CAS (REJ 674), F, 1 Aug. 1973, (79 in.), 223 cm,* 61 otoliths.—*Lagenorhynchus*: CAS 16593 (2336), M, 28 Sep. 1972, 190 cm, 47 otoliths; CAS 16342 (2380), F, 20 Apr. 1973, 193 cm,* 4 otoliths.—*Kogia*: CAS 16635 (2382), M, 25 May 1973, 204 cm, 2 otoliths and 231 cephalopod beaks.

Santa Cruz Co.—*Phocoena*: CAS 21381 (KB 19-73), M, 13 Apr. 1973, 134 cm, 17 otoliths; (KB 17-73), F, 1973, 104 cm, empty.

Monterey Co.—*Phocoena*: CAS 21387 (REJ 687), F, 22 Sep. 1973, 107 cm, empty; CAS 21383 (REJ 673), M, 24 July 1973, 126 cm, 48 otoliths, 1 pair cephalopod beaks; CAS 21385 (REJ 661), F, 17 June 1973, 104 cm, 16 otoliths, 3 cephalopod beaks; CAS 21386 (REJ 654), F, 24 Apr. 1973, 137 cm, 15 otoliths; CAS 21389 (REJ 653), M, 25 Apr. 1973, 145 cm, 13 cephalopod beaks; CAS 21388 (REJ 450), ? sex, 24 July 1971, no tl, 127 otoliths, 52 cephalopod beaks; CAS 21384 (REJ 449), ? sex, 24 July 1971, 108 cm, empty; CAS 21382 (REJ 241), F, 6 June 1970, 172 cm, 16 cephalopod beaks.—*Lagenorhynchus*: CAS 21370 (REJ 652), F, 21 Apr. 1973, 187 cm, 4 otoliths; CAS 21378 (REJ 625), M, 14 May 1973, 177 cm, 147 cephalopod beaks; MVZ (REJ 237), F, 29 May 1970, 180 cm, 7 cephalopod beaks.

---

* Indicates original data taken in inches.

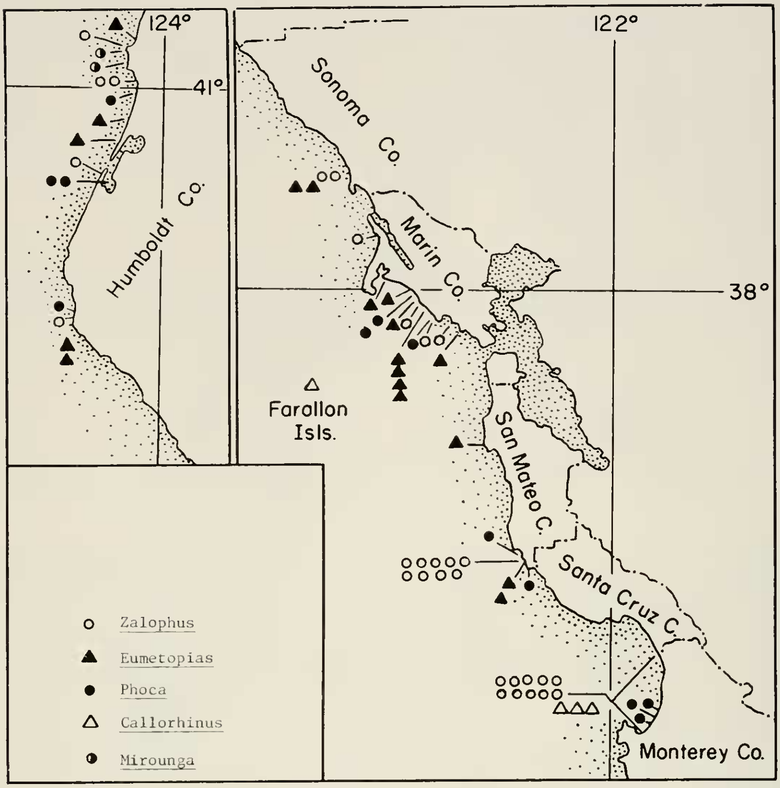

FIGURE 2. Localities of pinniped beach-cast specimens in north-coastal California, 1968–1973.

PINNIPEDS

Humboldt Co.—*Zalophus*: CAS 21401 (REJ 248), M, 16 June 1970, 256 cm, 17 otoliths; HSC 3206 (69-34), M, 1 June 1969, 233 cm,* 52 otoliths; HSC 3205 (REJ 69-33) M, 27 May 1969, 228 cm,* 122 otoliths; HSC 3204 (REJ 69-32), M, 23 May 1969, 249 cm,* 93 otoliths; HSC 3125 (REJ 69-31), M, 14 May 1969, 239 cm,* 152 otoliths.—*Eumetopias*: CAS 21391 (REJ 683), F, 16 Sep. 1973, 111 cm, empty; CAS 21390 (REJ 672), M, 20 July 1973, 309 cm, empty; HSC, (REJ 655), F, 1 May 1973, 200 cm, stones only; HSC, (REJ 247), M, 14 June 1970, 257 cm, 76 otoliths, 2 cephalopod beaks; MVZ 140847 (REJ 249), F, 16 June 1970, 259 cm, 66 otoliths, 13 cephalopod beaks; HSC, (REJ 69-8), F, 16 Feb. 1969, 251 cm,* 2 otoliths, 1 cephalopod beak.—*Phoca*: CAS 21421 (REJ 684), F, 17 Sep. 1973, 147 cm, empty; HSC 1188 (REJ 69-24), F, 25 Apr. 1969, 149 cm, 13 otoliths; HSC, (REJ 68-38), M, 28 July 1968, 162 cm, 3 otoliths; HSC, (REJ 68-14), F, 6 Apr. 1968, 102 cm, 17 otoliths.—*Mirounga*: HSC 2165 (REJ 69-6), F, 19 Feb. 1969, 152 cm, 1 *Apristurus brunneus* egg; HSC 1356 (?), F, 5 May 1970, no tl, 26 otoliths.

Sonoma Co.—*Zalophus*: CAS 21402 (REJ 680), M, 17 Aug. 1973, 238 cm, empty; CAS 21403 (REJ 660), M, 5 June 1973, 215 cm, 98 otoliths, 1 cephalopod beak.—*Eumetopias*: CAS 21392 (REJ 688), M, 23 Sep. 1973, 152 cm, 4 otoliths; CAS 21393 (REJ 679), F, 17 Aug. 1973, 229 cm, empty.

San Francisco Co..—*Callorhinus*: MVZ 140846 (REJ 212), F, 5 Feb. 1970, 131 cm, 7 isopods.

Marin Co.—*Zalophus*: CAS 21404 (REJ 700), M, 29 Sep. 1973, 210 cm, empty; PORE 138 (REJ 657), M, 9 May 1973, 230 cm, 1 otolith; CAS 21405 (REJ 641), M, 1 Mar. 1973, 220 cm, empty; CAS 16184 (2316), M, 19 July 1973, 158 cm, 1 otolith, 1 cephalopod.—*Eumetopias*: CAS 21399 (REJ 682), M, 6 Sep. 1973, 325 cm, empty; CAS 21395 (REJ 677), F, 7 Aug. 1973, 235 cm, broken otoliths and rocks; PORE 136 (REJ 676), M, 6 Aug. 1973, 280 cm, empty; CAS 21395 (REJ 668), F, 22 June 1973, 234 cm, empty; ?(REJ 637), 21 Oct. 1972, no tl, 22 otoliths, 4 cephalopod beaks; CAS 21397 (REJ 635), F, 16 Sep. 1972, 232 cm, empty; CAS 21396 (REJ 629), M, 22 July 1972, 228 cm, 59 otoliths, 5 cephalopod beaks; PORE 137 (REJ 453), F, 14 Aug. 1971, 226 cm, empty.—*Phoca*: PORE 214 (REJ 681), F, 29 Aug. 1973, 140 cm, empty; CAS 21423 (REJ 669), M, 22 June 1973, 97 cm, 3 *Crago* sp.; CAS 21422 (REJ 642), M, 1 Mar. 1973, 158 cm, empty.

San Mateo Co.—*Zalophus*: CAS 21412 (REJ 698), M, 28 Sep. 1973, 160 cm, empty; CAS 21411 (REJ 697), M, 28 Sep. 1973, no tl, empty; CAS 21410 (REJ 695), M, 28 Sep. 1973, 218 cm, empty; CAS 21409 (REJ 693), M, 28 Sep. 1973, 213 cm,* empty; ?(REJ 692), M, 28 Sep. 1973, 152 cm (est.), 2 otoliths, 2 cephalopod beaks; CAS 21408 (REJ 691), F, 28 Sep. 1973, no tl, empty; CAS 21407 (REJ 690), M, 28 Sep.

TABLE 2. AVERAGE STOMACH VOLUME OF THREE SPECIES OF MARINE MAMMALS AS MEASURED BY WATER DISPLACEMENT

Species	*n*	Sex	Total length of animal (cm) Range	Total length of animal (cm) Average	Volume of stomachs (l) Range	Volume of stomachs (l) Average
Zalophus						
Adults	6	M	198–256	223	9.42–19.84	12.63
Subadults	4	M	126–160	145	1.72–9.12	5.75
Eumetopias						
	3	M	280–325	305	22.20–46.72	33.67
	4	F	200–235	230	9.80–23.74	17.78
Phocoena						
	3	M	126–145	136	1.10–1.43	1.28
	5	F	95–159	120	7.00–2.25	2.44

1973, 196 cm, empty; CAS 16302 (2383), M, 27 May 1973, 122 cm, empty; MVZ 139211 (LGB 317), M, 24 Mar. 1970, no tl, 18 otoliths.—*Eumetopias*: ?(REJ 699), F?, 28 Sep. 1973, 192 cm, 24 otoliths, 1 cephalopod beak; CAS 21400 (REJ 694), M, 28 Sep. 1973, no tl, empty; CAS 21398 (REJ 675), F, 2 Aug. 1973, 220 cm, 1 otolith.—*Phoca*: ?(REJ 696), F, 28 Sep. 1973, 133 cm, 9 otoliths, 13 cephalopod beaks; CAS 21424 (REJ 689), F, 28 Sep. 1973, 139 cm, 15 *Eptatretus stoutii* eggs.

Monterey Co.—*Zalophus*: CAS 21415 (REJ 686), M, 22 Sep. 1973, no tl, 7 otoliths; ?(REJ 685), M, 22 Sep. 1973, 142 cm, 18 otoliths; CAS 21420 (REJ 667), M, 19 June 1973, 195 cm, 7 otoliths; CAS 21417 (REJ 666), M, 19 June 1973, 256 cm, 3 otoliths; CAS 21416 (REJ 665), M, 19 June 1973, 198 cm, 48 otoliths, 40 cephalopod beaks; CAS 21419 (REJ 664), M, 19 June 1973, 151 cm, 221 otoliths; CAS 21418 (REJ 662), M, 19 June 1973, 126 cm, 1 otolith, 3 cephalopod beaks; CAS 21414 (REJ 647), M, 1 Apr. 1973, 115 cm, 1 otolith, 3 cephalopod beaks; UC tag 6588 (REJ 244), M, 6 June 1970, 125 cm, 2 otoliths, 3 cephalapod beaks; CAS 21413 (REJ 68-40), M, 12 June 1968, 233 cm,* 39 otoliths.—*Phoca*: CAS 21427 (REJ 671), M, 13 June 1973, 98 cm, 1 otolith; CAS 21426 (REJ 663), F?, 19 June 1973, 87 cm, empty; CAS 21425 (REJ 646), F, 1 Apr. 1973, 142 cm, 10 cc fish bones, 3 cephalopod beaks.—*Callorhinus*: MVZ 153256 (REJ 645), F, 1 Apr. 1973, 121 cm, empty; ?(REJ 243), F, 6 June 1970, 101 cm, 12 otoliths, 14 cephalopod beaks; MVZ 138677 (REJ 69-36), F, 12 July 1969, 137 cm, empty.

RESULTS

Sixty-eight percent of the 102 stomachs examined in this study contained material (Table 1), approximately the same percentage as recorded for stomachs from collected living marine mammals. For example, 331 of 437 stomachs (76 percent) of the fur seals taken off California in 1966 contained food (Marine Mammal Biological Laboratory 1969), and 18 of 44 (41 percent) California sea lions taken recently in Oregon contained food (Mate 1973). Normally about 60 percent of the northern sea lions collected during daylight hours have food in their stomachs (Spalding 1964), but Mathisen et al. (1962) found food in 82 percent (114 stomachs). Forty percent of 1300 fur seal stomachs examined in Alaska contained food (Scheffer 1950a).

Fish otoliths or other dietary remains were recovered from 61 stomachs, and 33 stomachs had remnants of identifiable invertebrates (Tables 3, 4, 5, and 9). The items in the stomachs included fish bones and otoliths, parasites, seaweeds, fish egg cases, cephalopod tissue and beaks, eye lenses of fish and cephalopods, rocks, wood, and parts of other invertebrates.

Fitch and Brownell (1968) have presented a valid case for the use of otoliths in determination of dietary habits. Other investigators also have found undigested parts such as otoliths and cephalopod beaks in the forestomachs of cetaceans (Rae 1965; Harrison et al. 1970; Iverson and Pinkas 1971; Loeb 1972; Smith and Gaskin 1974).

Phoca vitulina, Harbor seal

Harbor seals in the Aleutians contained fewer prey species than in other areas studied. Wilke (1957) examined seven harbor seals collected in March at Amchitka Island and found that octopus was the most frequent item, but that gadid and hexagrammid fishes made up the greatest volume of food present. A later study by Kenyon (1965) found only octopus (*Octopus* sp.) and Atka-mackerel (*Pleurogrammus monopterygius*) in 11 seals at Amchitka Island. He theorized that harbor seals feed during the daylight hours as suggested by the freshness and large volumes of food in the stomachs. Kenyon failed to consider Wilke's earlier study which indicat-

TABLE 3. TOTAL NUMBER OF FISH OTOLITHS FOUND IN 22 SPECIMENS OF CETACEANS, NORTH-CENTRAL CALIFORNIA, 1968–1973.

Prey species	*Phocoena* (14) No. otoliths	*Phocoena* (14) Percent total	*Phocoenoides* (2) No. otoliths	*Phocoenoides* (2) Percent total	*Lagenorhynchus* (5) No. otoliths	*Lagenorhynchus* (5) Percent total	*Delphinus* (1) No. otoliths	*Delphinus* (1) Percent total
Rockfishes (Scorpaenidae)	1017	(71.8)	0	–	8	(9.2)	0	–
Northern anchovy	253	(17.8)	0	–	5	(5.7)	0	–
Pacific hake	74	(5.8)	61	(91.1)	3	(3.5)	0	–
Smelts (Osmeridae)	9	(0.15)	0	–	34	(39.0)	1	(9.1)
Pacific tomcod	34	(2.3)	6	(8.9)	0	–	0	–
Plainfin midshipman	2	(0.14)	0	–	34	(39.0)	0	–
Flatfishes (Pleuronectidae)	13	(0.92)	0	–	1	(1.2)	0	–
Medusafish	0	–	0	–	0	–	10	(90.9)
Surfperches (Embiotocidae)	9	(0.63)	0	–	0	–	0	–
Spotted cusk-eel	2	(0.14)	0	–	0	–	0	–
Jackmackerel	0	–	0	–	2	(2.3)	0	–
Total	1413	(99.68)	67	(100)	87	(99.9)	11	(100.0)

ed that the abundant rock greenling (*Hexagrammos lagocephalus*) made up 96 percent of food volume from harbor seals. Total sample size during March for both Wilke (1957) and Kenyon (1965) was 10 specimens, which is hardly adequate for the construction of generalities. Yet Kenyon's (1965) study is the basis for Morejohn and Baltz's (1970) model for selective feeding. They looked at a single elephant seal and compared its feeding behavior to that of harbor seals at Amchitka. The sample sizes in these studies are barely adequate for comparison, and are inadequate for feeding models.

The diet of harbor seals varies greatly with season and location of populations. Pelagic, bottom-dwelling, and anadromous fishes have all been reported in its diet. Captain Scammon (1874) noted that the "Leopard Seal" pursued and devoured small fish.

During a two-year study in Alaska (Imler and Sarber 1947), 166 (41.5 percent) of 400 harbor seal stomachs contained identifiable food items. In the Copper River flats of Alaska, 67 seals fed almost entirely on eulachon (*Thaleichthys pacificus*). Ninety-nine other specimens from southeastern Alaska had fed on walleye pollock (*Theragra chalcogramma*) and Pacific tomcod (*Microgadus proximus*) (22.6 percent), Pacific herring (*Clupea harengus pallasii*) (16.4 percent), and flounders (11.1 percent). Lesser numbers (29.5 percent) of salmonids, sculpins, rockfish, blennies, and skates were reported. Imler and Sarber (1947) also found shrimp and octopus (20.6 percent) in harbor seals from Alaska.

Spalding (1964) collected harbor seals throughout the year in British Columbia; 57 of the 126 stomachs were empty. He found that minimal food was consumed during the June to September pupping season. In summer, the stomachs contained cephalopods (35.4 percent), rockfish (22.6 percent), and salmon (16.1 percent). Stomachs collected from September to December contained invertebrates (34.8 percent), herring (10.8 percent), and salmon (30.4 percent). Fish of commercial value composed 54 percent of the harbor seals' diet on a yearly basis.

In Puget Sound also the harbor seal is a generalized feeder (Scheffer 1928). Scheffer and Sperry (1931) point out that fishes made up 93.6 percent, molluscs 5.8 percent, and crustaceans 0.6 percent of the total volume of harbor seal stomach contents. Only two percent of the harbor seal stomachs contained salmon (Scheffer and Slipp 1944). Studies in Washington (Scheffer 1928; Scheffer and Sperry 1931; Scheffer and Slipp 1944; Seed 1972) revealed that the major prey species were flatfishes: English sole (*Parophrys vetulus*), flathead sole (*Hippoglossoides elassodon*), Pacific herring, Pacific tomcod, Pacific hake (*Merluccius productus*), sculpins (*Leptocottus armatus, Myoxocephalus* sp.), walleye pollock, surfperches (*Cymatogaster aggregata, Rhacochilus* sp.), Pacific cod (*Gadus*

TABLE 4. TOTAL NUMBER OF FISH OTOLITHS FOUND IN 38 SPECIMENS OF PINNIPEDS, NORTH-CENTRAL CALIFORNIA, 1968–1973.

	Phoca (6)		*Zalophus* (20)		*Eumetopias* (9)		*Callorhinus* (1)		*Mirounga* (2)	
Prey species	No. otoliths	Percent total	No. otoliths	Percent total	No. otoliths	Percent total	No. otoliths	Percent total	No. otoliths	Percent total
Pacific hake	1	(2.3)	574	(62.8)	55	(21.7)	0	–	26	(96.3)
Northern anchovy	0	–	218	(23.8)	1	(0.4)	12	(100)	–	–
Rockfishes (Scorpaenidae)	1	(2.3)	57	(6.2)	79	(31.2)	0	–	0	–
Flatfishes (Pleuronectidae)	4	(9.3)	1	(0.1)	44	(17.3)	0	–	0	–
Spotted cusk-eel	0	–	6	(0.6)	30	(11.8)	0	–	0	–
Plainfin midshipman	0	–	30	(3.2)	1	(0.4)	0	–	0	–
Sablefish	0	–	0	–	22	(8.7)	0	–	0	–
Surfperches (Embiotocidae)	18	(41.9)	3	(0.3)	0	–	0	–	0	–
Pacific herring	0	–	16	(1.7)	1	(0.4)	0	–	0	–
Lingcod	0	–	1	(0.1)	13	(5.1)	0	–	0	–
Blackbelly eelpout	12	(27.9)	0	–	1	(0.4)	0	–	0	–
Jackmackerel	0	–	3	(0.3)	3	(1.2)	0	–	0	–
Smelts (Osmeridae)	0	–	2	(0.2)	2	(0.2)	0	–	0	–
Kelp greenling	4	(9.3)	0	–	0	–	0	–	0	–
Pacific tomcod	2	(4.7)	1	(0.1)	0	–	0	–	0	–
Brown cat shark	0	–	0	–	1	(0.4)	0	–	1	(3.7)
Pacific hagfish	1	(2.3)	0	–	0	–	0	–	0	–
Chinook salmon	0	–	1	(0.1)	0	–	0	–	0	–
Queenfish	0	–	1	(0.1)	0	–	0	–	0	–
Blacktail snailfish	0	–	0	–	1	(0.4)	0	–	0	–
Total	43	(100)	914	(99.6)	254	(99.6)	12	(100)	27	(100)

macrocephalus), and lingcod (*Ophiodon elongatus*). These authors list 13 kinds of crustacea and 4 kinds of mollusca from the stomachs of harbor seals. Harbor seals eat flounder, sole, herring, eel, goby, cod, whiting, squid, whelks, crab, and mussels (King 1964). Fishes, squid, octopus, and shellfish constitute the diet of harbor seals in California (Daugherty 1972). Bonnot (1951) indicated that the fishes, molluscs, and crustaceans consumed by harbor seals in California are usually slow-moving or sedentary forms. The above authors do not specify scientific names nor document sources for their dietary information.

I examined stomachs of 12 harbor seals of which eight with food had eaten eight kinds of fish (*Merluccius productus, Microgadus proximus, Lycodopsis pacifica, Sebastes* spp., *Hexagrammos decagrammus, Embiotoca jacksoni, Phanerodon furcatus, Glyptocephalus zachirus*), one kind of octopus (*Octopus* sp.), and one kind of shrimp (*Crago* sp.). Embiotocid perch constituted 41.9 percent of my sample, compared with 11 percent in Washington (Scheffer and Sperry 1931). One harbor seal (REJ 689) had

TABLE 5. MINIMUM NUMBER OF INDIVIDUAL FISH AND CEPHALOPODS FOUND IN ELEVEN SPECIES OF MARINE MAMMALS, NORTH-CENTRAL CALIFORNIA, 1968–1973.

	Cephalopods		Fishes	
	Minimum no. individuals represented	No. beaks	Minimum no. individuals represented	No. otoliths
Zalophus	32	51	476	922 (8*)
Eumetopias	11	27	132	258 (5*)
Phoca	12	16	23	43 (1*)
Callorhinus	7	14	6	12
Mirounga	0	0	13	26
Phocoena	92	168	712	1429 (16*)
Phocoenoides	0	0	34	67
Lagenorhynchus	86	155	45	88 (1*)
Delphinus	3	4	6	11
Kogia	112	217	1	2
Grampus	0	0	0	0
Totals	355	652	1448	2858 (31)

* Unidentifiable.

TABLE 6. NUMBER OF INDIVIDUAL FISH, GROUPED BY NICHE, FOUND IN THE STOMACHS OF MARINE MAMMALS FROM NORTH-CENTRAL CALIFORNIA, 1968–1973.

	Sample size	Schooling (open water)	Bottom-dwelling (rocky)	Inshore (schooling)
Zalophus	30	296	52	121
Eumetopias	19	28	97	3
Phoca	12	2	24	0
Mirounga	2	13	0	0
Callorhinus	4	0	0	6
Phocoena	20	52	13	646
Lagenorhynchus	7	3	22	20
Phocoenoides	5	33	0	0
Delphinus	1	5	0	1
Grampus	1	0	0	0
Kogia	1	0	1	0

ingested Pacific hagfish (*Eptatretus stoutii*) egg cases (15 eggs). I observed that Pacific hagfish or Pacific lamprey (*Lampetra tridentata*) was a prey item of seals near river mouths in northern California. Scheffer and Sperry (1931) note that two percent of stomachs in which items occurred contained Pacific lamprey.

At birth, harbor seals average 81.6 cm in length (Bigg 1969). I examined two pups (98 and 97 cm) which contained solid food: an otolith (*Sebastes* spp.) in one stomach and a number of shrimp (*Crago* sp.) in the other. This suggests that harbor seals catch their own food at an early age.

In summary, knowledge to date indicates that harbor seals feed on shallow-water fishes and bottom-dwelling invertebrates (Tables 1, 6 and 9).

Mirounga angustirostris, Elephant seal

Pike and MacAskie (1969) reported hagfish eggs (*Eptatretus*) and probably digested hagfish remains in an elephant seal from Canada. Huey (1930) pointed out that several of the fish species found in elephant seal stomachs inhabit water from 50 to 120 fathoms (ca. 91 to 219 m) deep. Small sharks (*Squalus, Cephaloscyllium*), skates (*Raja*), rays (Myliobatidae), and ratfish (*Hydrolagus*) have been reported as food items in elephant seals (Kenyon and Scheffer 1955; King 1964; Daugherty 1972; Seed 1972). Huey (1925) found that three of four Guadalupe Island elephant seals contained squid (*Loligo*).

Contrary to the report of Morejohn and Baltz (1970), teleost fishes had been reported from elephant seals. Huey (1930) reported a single bass, and Daughterty (1972) stated that elephant seals eat rockfish. Freiburg and Dumas (1954) found a dead adult elephant seal in Oregon which may have died from bones of Pacific hake (*Merluccius productus*) blocking the internal nasal region.

More information is needed on fish ecology and fish population abundance before the nature of feeding behavior of elephant seals can be clarified. The elephant seal may be a selective feeder (Morejohn and Baltz 1970), but seasonal, sex, and age factors need to be resolved. Commercial catches are the reference for fish abundance by Morejohn and Baltz. However, commercial fish catches are a poor indication of fish abundance when most reported fish are of commercial value (Bell 1971). Anyone accompanying commercial vessels realizes that many unreported fish are caught besides those marketed. All fishes Morejohn and Baltz found were bottom or rock-dwelling species (*Chilara, Porichthys, Sebastes,* and *Lyopsetta* or *Glyptocephalus*).

Elephant seals may feed during particular periods of the day. If they are nocturnal feeders, they may catch hake high in the water column, but diurnal feeding would suggest that hake are taken in deep water (Nelson and Larkins 1970). Studies are needed to determine when and where elephant seals feed. Large fish otoliths may indicate offshore feeding by the elephant seal.

To date, few elephant seals have been examined for stomach contents. One of my seals, an immature female (HSC–1970) found dead in Humboldt County on 5 May 1970, contained 26 otoliths from Pacific hake, representing at least 12 adult fish. Hake migrate north along the coast in spring and summer and might be expected to be present in marine mammal diets at that time of year. Pacific hake form massive schools just above the bottom and show a pronounced daily vertical migration (Nelson and Larkins 1970). Most adult hake are located beyond the continental shelf at depths of 230–410 m. Although Pacific hake are present in commercially abundant numbers, they are not being exploited currently by American fisheries. Pacific hake ranked second in abundance in California larval surveys (Ahlstrom 1965).

My other specimen, also an immature female, was found in Trinidad, Humboldt County, 19 Feb. 1969 (HSC–69-6). It contained a single egg case of the brown cat shark (*Apristurus brunneus*), which was identified using the description and photos in Cox (1963). This species of shark is found in deep water from British Columbia to Baja California.

Eumetopias jubatus, Northern sea lion

The northern sea lion has been studied more intensively than most other North Pacific pinnipeds. This sea lion occurs along the eastern Pacific coasts from Alaska to California, where its relationships to commercial fisheries have been studied extensively. In general, these studies reveal that fish and cephalopods are the preferred foods.

In 1899 L. L. Dyche inspected 25 sea lion stomachs from near Monterey Bay, California. All specimens referred to by Dyche contained squid or octopus.

The original manuscript Dyche sent to C. H. Merriam in 1901 did not specify which sea lion was involved. This partially handwritten document mentioned only the common identification "California Sea Lion" (Unpublished manuscript, Dyche 1901. C. H. Merriam file at Museum of Vertebrate Zoology, University of California, Berkeley). When Merriam (1901a, 1901b) first published Dyche's data, he did not indicate whether the northern sea lion (*Eumetopias*) or the California sea lion (*Zalophus*) was involved. Later, Dyche (1903) used the name "*Zalophus californianus* Lesson" beneath the general title of "Food for California Sea Lions," suggesting that California sea lions were examined. Thus it was long believed that all sea lions examined by Dyche were *Zalophus*. Briggs and Davis (1972) have pointed out that at least some of Dyche's specimens were *Eumetopias jubatus*. Since only 7 of these 25 sea lions deposited at the University of Kansas are extant today, it is not possible to make positive identifications for all of Dyche's specimens (R. S. Hoffmann, Curator Univ. of Kansas, pers. comm. [1973]). Although the 7 extant specimens are northern sea lions, it is possible that all 25 of the originally collected specimens may not have been this species.

Northern sea lions have been reported to feed at night (Rowley 1929; Bonnot 1951; Mathisen 1959; Mathisen et al. 1962; Spalding 1964; Seed 1972; Mate 1973). Fiscus and Baines (1966) sighted feeding groups of up to several thousand animals 8–22 km out in Unimak Pass, Alaska. It would be of interest to know if the individuals observed feeding returned to the hauling-out area each afternoon with engorged stomachs. Daytime feeding behavior has been noted by many fishermen, specifically long-line and dragboat operators (Kenyon 1952a).

An interesting examination at the cannery dock at the mouth of the Klamath River was reported by Bonnot (1951). Two half-grown northern sea lions were killed, and only lampreys were found in their stomachs. J. C. Snyder also examined sea lions at river mouths and identified the remains of lampreys in their stomachs (Kenyon 1952b). More recently, Jameson and Kenyon (1978) reported that 82 percent of observed feeding behavior at the Rogue River, Oregon, was on lampreys.

Rutter et al. (1904) presented data on 18 northern sea lions (6 males and 12 females) from north-central California. The eight female sea lions containing food were taken from Año Nuevo Island in July or August. Five male sea lions from Pt. Arena ate at least 147 fish but only 5 squid. The majority of their food was fish (257 fish present in the 13 animals). The only cephalopod material was from five sea lions from both areas. This low incidence of cephalopods does not agree with the findings of Dyche (1903), but the identity of Dyche's specimens is in doubt. In contrast, in southern California Rutter et al. (1904) found only 39 fish but thousands of cephalopods in a sample of 24 *Zalophus*. They concluded that the northern sea lion feeds chiefly on fish, and the California sea lion on cephalopods, and that both feed opportunistically.

Bonnot (1928) examined two northern sea lion stomachs from San Miguel Island, California, on 20 June 1928. The adult male was empty but the female contained three greenish eggs of a skate or shark. Bonnot stated that this was an old, blind sea lion and perhaps she was dying. In northern California, at the Saint George Reef rookery (Del Norte County), Bonnot found thousands of shells of a tiny pelecypod embedded in sea lion feces. Other investigators have not reported analysis of scats, perhaps because of the difficulty of locating adequate samples (Bonnot 1928).

The literature contains a composite list of 32 fishes from stomachs of northern sea lions (Table 7). Because of the nonspecific categories of some fish names, I have not attempted to produce an accurate species list. Only the papers

TABLE 7. SUMMARY OF FOOD CONTENTS OF *Eumetopias* (modified from Pike (1958) with recent additions).

Locality	Season and year	Source	No. of stomachs (size and/or sex)	No. of stomachs, kinds of food
St. Paul I., Alaska	July 1949–1951	(6)	22 (2 females)	19—empty, 1—ceph. beak, 1–10 lbs., sandlance trace-starry flounder, sculpin, 1–20 lbs. halibut, cod, flounder, pollack, 4—large stones
Sitka to Kodiak I., Alaska	May, July, Aug. 1945–1946	(4)	23 (adults)	8–empty, 15—salmon, cod, halibut, pollack, 4—octopus
Kodiak to Krenitzin I., Alaska	May–July 1959	(8)	382 (372 males, 10 females)	326—empty, 28—fish (7 spp.), 21—invertebrates, 20—squid and octopus, 10—no ID fish, 154—stones and gravel
Chernaburg I., Alaska	May, July 1958	(7)	114 (46 males, 51 females, 17 yearlings)	20—empty, 31—fish (7 spp.), 61—invertebrates, 73—rock and sand, 24—no ID fish, 5—milk
Beresford I., B.C.	Aug. 1913	(2)	3 (adults)	2—empty, 1—salmon, "cod" and "bass"
Scott I., B.C.	June, July 1956	(5)	56 (adults)	50—empty, 4—fish and squid, 1—herring, 1—octopus
Scott I., B.C.	June 1957	(5)	8 (4 females, 4 males)	6—empty, 1—salmon, 1—no ID fish
Barkley Sound, B.C.	Dec. 1915	(2)	14 (11 males, 3 females)	12—herring, 1—clamshell, 1—crab, octopus
Barkley Sound, B.C.	Feb., Apr. 1958	(5)	14 (13 females, 1 male)	6—empty, 3—herring, 2—rockfish, 2—fish/octopus, 1—octopus, skate, hake
Isnor Rock, B.C.	July, Aug. 1957	(5)	3 (young males)	1—rockfish, 1—squid and rockfish, 1—squid
British Columbia	Feb.–Dec. 1959	(9)	393 (equal numbers, males/females)	213—empty, 75—fish (17 spp.), 49—no ID, milk or kelp
Offshore California–N. Pacific	Mar., Sep. 1958–1963	(10)	34 (7 males, 15 females)	11—lost at sea, 22—fish (15 spp.), 2—no ID fish, 1—clamshell and fish, 9—rocks and pebbles
Pt. Arena and Año Nuevo I., Calif.	July–Aug. 1901	(1)	18 (6 males, 12 females)	5—empty, 13—fish, 6—squid and octopus

TABLE 7. CONTINUED.

Locality	Season and year	Source	No. of stomachs (size and/or sex)	No. of stomachs, kinds of food
Año Nuevo I., Calif.	"several years ago" prior to 1918	(3)	15 (14 females, 1 young male)	7—empty, 8—rock, sardines, salmon, 3—fish and squid
North-Central California	1968–1973	(11)	19 (7 males, 12 females)	10—empty, 9—fish, 7—squid and octopus, 2—rocks

(1) Rutter et al. 1904.
(2) Newcombe et al. 1918.
(3) Starks 1918.
(4) Imler and Sarber 1947.
(5) Pike 1958.
(6) Wilke and Kenyon 1952.
(7) Mathisen et al. 1962.
(8) Thorsteinson and Lensink 1962.
(9) Spalding 1964.
(10) Fiscus and Baines 1966.
(11) Current study 1973.

of Wilke and Kenyon (1952), Spalding (1964), and Fiscus and Baines (1966) present scientific names and volumetric determinations which enable me to present a well-documented dietary list. Pike (1958) also presented a table with stomach contents. All of these data are updated and presented as Table 7.

My study adds 10 genera of fishes to those previously reported from northern sea lions, as follows: *Microstomus*, *Parophrys*, *Careproctus*, *Lyopsetta*, *Eopsetta*, *Glyptocephalus*, *Porichthys*, *Engraulis*, *Spirinchus*, and *Chilara*. These 10 genera constituted 31.1 percent of the otoliths found in *Eumetopias*.

All northern sea lion stomachs which contained cephalopod beaks also had remains of from 2 to 13 species of fish (Table 5). Four species of cephalopods were identified: *Loligo opalescens*, *Octopus* sp., *Chiroteuthis* sp., and *Onychoteuthis* sp. Most beaks were so thoroughly digested that specific identifications were impossible. One male sea lion (REJ 629) had eaten at least 3 octopus plus 13 species of fish. More surprising than the variety of prey eaten was the fact that the sea lion had been eating during the breeding season when most *Eumetopias* males fast (Spalding 1964).

In my study demersal fish were found in six of the nine stomachs containing fish. When the 127 identified fishes from northern sea lions are grouped according to schooling (open-water), bottom-dwelling (rocky), and inshore-schooling species (Table 6), it is apparent that the northern sea lion feeds mainly on bottom-dwelling fishes. The rather high incidence of rocks in the stomachs also suggests a bottom-feeding habit (Tables 1 and 9).

Zalophus californianus, California sea lion

California sea lions make annual north–south migrations along the Pacific Coast of North America. Adult and subadult males move northward during September and October after the breeding season (Bonnot 1928; Fry 1939; Orr and Poulter 1965, 1967; Bartholomew 1967; Peterson and Bartholomew 1967; Peterson and LeBoeuf 1969; Odell 1971) and return south in March to the more southern breeding rookeries.

Virtually nothing is known about the feeding behavior of migrating California sea lions. Peterson and LeBoeuf (1969) indicated that influxes of sea lions into northern areas are correlated with periods of abundance of food, but they did not document their statement.

No published studies have been reported on California sea lions between Monterey Bay and the Oregon border. B. R. Mate (Oregon State Univ., pers. comm. [1971]) collected 44 male California sea lions in Oregon, but he has not yet identified the fish otoliths. From the data presented by Mate (1973), one can calculate that 40.9 percent of the combined sample of deliberately collected sea lions contained food. My method of obtaining stomach data showed that 66.6 percent of the beached California sea lions contained food.

Fiscus and Baines (1966) examined six California sea lions taken during a recent study on fur seals. The stomach volume was recorded; thus the estimate for feeding rates and food intake to body weight can be determined more clearly. *Loligo opalescens* (common squid), unidentified squid, northern anchovy, and Pacific hake were found in these pelagic California sea lions.

Several observations have been made of feeding sea lions. Fink (1959) reported a single observation, on 25 Feb. 1959, in Monterey Bay of California sea lions attacking a school of Pacific sardines. Although feeding on sardines is surely not uncommon, his vivid description of harbor porpoises controlling the fish school and the sea lions feeding on the periphery of the school is the only published account of such behavior. Ryder (1957) reported feeding aggregations of pinnipeds and birds. At the Farallon Islands, California, an adult male California sea lion was seen repeatedly eating several jackmackerel during the daylight hours on 17 and 19 September 1973 (T. James Lewis and Barbara Lewis, Point Reyes Bird Observatory, pers. comm.). At Cerros (Cedros) Island, Baja California, a female California sea lion was observed feeding beneath the surface by Bonnot (1932b), who watched this cow eat at least six large flying fish (Exocoetidae).

Scheffer and Neff (1948) noted that the analysis of only 58 California sea lion stomachs had been reported in the literature. Of these, Dyche's 25 specimens from the Monterey area are either misidentified or of questionable identity. Scheffer and Neff examined four sea lion stomachs from southern California. Two females were empty, but the other female contained evidence of at least 21 small squid. The single male found dead near La Jolla on 26 Nov. 1943 had 36 nearly whole Pacific herring plus fragments representing 30 other herring. All California sea lions analyzed by Scheffer and Neff were from south of Point Conception.

Rutter et al. (1904) examined stomachs of 24 California sea lions, 13 with food, in July and August 1901 at southern California localities. The eight females each had 100 to 300 small squid parts. Squid pens were food remnants in the stomachs of three of the five males. The remaining stomach contents consisted of hake, rockfish, ratfish, unidentified small fish, and milk. Bonnot (1928) reported on these same specimens and stated that 5 had eaten fish and 11 had eaten squid. Starks (1918) pointed out that stomachs of two of the breeding bulls that Rutter et al. examined did not contain any food.

According to a recent survey by scientists at the Scripps Institution of Oceanography and presented to the California Senate Fact Finding Committee on Natural Resources (Anderson 1960), 24 of 30 stomachs from *Zalophus* contained food. The only identified items were fish otoliths, but many unidentified cephalopod beaks also were present. Carl L. Hubbs (Scripps Institution of Oceanography) and John E. Fitch (California Dept. of Fish and Game, Long Beach, pers. comm. [1973]) revealed that this study was done by the late Art Kelly in southern California and northern Mexico. The 424 fish otoliths which Kelly recovered were identified by Fitch as representing 24 kinds of fishes. Pacific hake were found in 17 of the 24 stomachs and constituted 48.1 percent of the total otoliths. The other fishes were cusk-eels, midshipmen, and species of rockfish. Sixty-six (15.6 percent) of the otoliths were of Pacific mackerel, anchovy, perch, and white croaker. These sea lions also fed extensively on squid and octopus, as represented by beaks in their stomachs.

Briggs and Davis (1972) spent 500 hours aboard sport and commercial salmon boats in Monterey Bay from 14 April to 22 September 1969. They observed seven instances of predation on salmon by California sea lions. Of the hooked fish, 4.1 percent were lost to sea lions. I found 10 dead California sea lions along Monterey Bay during the commercial salmon season (April to September). I also located an additional 20 California sea lion carcasses farther north (Figure 1). I found a single female California sea lion north of Monterey Bay. Only one salmon otolith was present among the 922 otoliths (461 fish represented) from my sample of California sea lions.

Male California sea lions feed on a variety of schooling fishes (Pacific hake, anchovy, rockfish, flatfish, cusk-eel, midshipmen, herring, lingcod, jackmackerel, salmon, and osmerids). Pacific hake and anchovy make up 86.6 percent by frequency of occurrence of otoliths from sea lion stomachs. Schooling fishes, both inshore and open-water types (417 otoliths) were found in California sea lions (Table 6).

Callorhinus ursinus, Northern fur seal

Wilke and Kenyon (1957) identified five species of fish from 204 seals (114 with food) collected from the Bering Sea and St. Paul Island. Seals collected at sea contained large numbers of capelin (*Mallotus villosus*) and walleye pollock (*Theragra chalcogramma*). Only one salmon (*Oncorhynchus* sp.) was found in the stomachs. Three seals killed on land at St. Paul Island collectively held one salmon (*Oncorhynchus* sp.), one walleye pollock, and two sandfish (*Trichodon*). Indian hunters took 41 seals (13 empty) 30 miles (about 48 km) off Washington in 1930. Although the stomach contents were digested, squid eyes and beaks were reported from 21, and identifiable herring vertebrae were present in 15 stomachs (Schultz and Rafn 1936). Clemens and Wilby (1933) looked at 25 stomachs from the west coast of Vancouver Island and reported that 8 contained squids, 9 had salmon, and the rest had small schooling fish. No data on the volume of the stomachs or the number of empty stomachs were reported.

Hanna (1951) recorded fur seals in the Gulf of the Farallons during February and April. Seals were described as competitors with W. I. Follett as he dip-netted for myctophid fish (*Tarletonbeania, Symbolophorus*), sablefish (*Anoplopoma fimbria*), and red Irish lord (*Hemilepidotus hemilepidotus*). Hanna also theorized that fur seals, porpoises, and sea birds were all feeding on pteropods (Mollusca).

More recently 437 stomachs from pelagic fur seals taken off California were examined (Marine Mammal Biological Laboratory 1969). Anchovy, saury, hake, and squid constituted 98 percent of the total food volume.

Scheffer (1950a) reviewed the dietary literature on fur seals. He presented data on only two northern fur seal stomachs from California, one of which contained an unidentified bird and the other had fed on Pacific saury (*Cololabis saira*).

Fur seals found on California beaches usually have little food in their stomachs. Likewise a fur seal from Southeast Farallon Island contained no food in its stomach (REJ 212), but had seven isopods (*Riggia*?) which are external parasites on fish. One beach-cast fur seal had 7 beaks of the common squid and 12 northern anchovy otoliths in its stomach (REJ 243).

Phocoena phocoena, Harbor porpoise

Although the diet of harbor porpoises in California waters is poorly known, herring, small cods, soles, and squid are food items of harbor porpoises generally (Ridgway 1972). Scammon (1874) wrote, "They feed upon fish, and are occasionally taken in seines that are hauled along the shores of San Francisco Bay by the Italian fishermen."

Harbor porpoises seldom are sighted more than 20 miles (about 32 km) offshore and usually are seen near harbor entrances (Fiscus and Niggol 1965). Local fish abundance and seasonal fish movements affect the diet of these porpoises (Rae 1965).

In Scottish waters, Rae (1965) examined 45 porpoises from November to March and 7 additional ones in the summer months. A few invertebrates were found which Rae thought might have been taken incidentally with other food items. Fish or fish remains were recognized in 41 of the 43 stomachs with recognizable food. One of the two remaining stomachs contained milk and the other the remains of a very small cephalopod. Ten species of fish were present, with herring (*Clupea harengus*) and whiting (*Gadus merlangus*) the most common. Most fish were less than 25 cm in length, with the largest individuals 35 cm. These harbor porpoises had been trapped in nets set for cod or salmon.

British naturalists have recorded food habits of harbor porpoises in the North Sea for more than 100 years, and small fish, mainly clupeoids (65 percent) and gadoids (30 percent), constitute the major foods taken (Rae 1965). Rae concluded that harbor porpoises take pelagic forms of fish. Tomilin (1957) found benthic fish predominating in the diet of harbor porpoises from the Black Sea and Sea of Azov. In a study in the Bay of Fundy, small schooling fishes (*Clupea harengus, Gadus morhua, Scomber scombrus*) were principal food items for harbor porpoises (Smith and Gaskin 1974). These schooling fishes accounted for 78 percent of the total diet.

Tomilin (1957) listed dietary items of harbor porpoises in the Black Sea, where 4000 stomachs were inspected. These porpoises fed upon eight benthic species and six pelagic species of fish. The pelagic fish were consumed when they occurred in large dense schools. One of two harbor porpoises found at Pt. Barrow, Alaska, contained bones of whitefish (*Leucichthys*) (Hall and Bee 1954). Pike and MacAskie (1969) reported a Canadian harbor porpoise caught in a gill net. This animal had one herring in its stomach.

Scheffer (1953) inspected a female porpoise from Grays Harbor County, Washington, which had fed on 37 capelin. Its death apparently was caused by an American shad blocking its throat passages. Five years earlier Scheffer had found on the same beach another porpoise which also had choked to death on a fish. A female porpoise from Port Townsend, Washington, May 1950, had eaten five Pacific herring (Wilke and Kenyon 1952).

Orr (1937) reported that a porpoise apparently choked to death on a gray smoothhound shark (*Mustelus californicus*). This single report of sharks as a food item may be abnormal. Fink (1959) observed for 30 minutes several hundred harbor porpoises feeding on a school of Pacific sardines northwest of Pt. Pinos, Monterey Bay. He vividly described the attack and herding of the sardines, and counted from 5 to 12 fish eaten by an individual porpoise in its attack through the sardines.

In my study, juvenile rockfish constituted 71.8 percent of the diet of harbor porpoises (Table 3). Five porpoises collected in June and July contained 1017 rockfish otoliths. Northern anchovy was the second most frequent fish and was found in seven porpoises from April to August. Over two-thirds of all fish found in stomachs of harbor porpoises live in open water or are inshore schooling species (Table 6). Juvenile Pacific hake, Pacific tomcod, rockfish, and northern anchovy accounted for 97 percent of all stomach otoliths found during my investigation (Table 3).

Invertebrate remains were found in 8 of the 20 porpoises examined (Table 9). A total of 141 *Loligo opalescens* beaks was identified from 168 cephalopod fragments. These beaks represent at least 92 individual cephalopods compared to at least 712 fish represented by 1429 otoliths (Table 5). One harbor porpoise (CAS 2392) had 13 intact *Loligo* and an additional 35 pairs of beaks in its stomach. The intact bodies of the 13 squids indicated harbor porpoises do not chew this food item.

Phocoenoides dalli, Dall's porpoise

This porpoise is much more common than early records indicate. Brownell (1964) reported its occurrence in southern California waters in the winter. Lustig (1948) saw 10 or 12 porpoises feeding on baitfish, anchovy or sauries, on 13 July 1939, in the Anacapa Passage.

Deep-water benthic fish and bathypelagic cephalopods were reported as major food items from a large sample of Dall's porpoise stomachs from Japan (Wilke and Nicholson 1958). Eleven percent of the food volume was squid: *Watasenia*, *Ommastrephes*, and unidentified genera. Myctophidae (lanternfishes) composed 70 and 73 percent of the stomach contents in 1949 and 1952, respectively.

Cowan (1944) took five (3 males and 2 females) Dall's porpoise off the coast of British Columbia in the summer of 1939. Four of the five stomachs were full of herring. Pike and MacAskie (1969) examined three males and two females from British Columbia, and they too found mostly herring or squid in three stomachs.

Scheffer (1953) recorded the stomach contents of six Dall's porpoises from Monterey and northward. These contained Pacific hake, squids (*Loligo opalescens* and unidentified species), jackmackerel, and unidentified fish. Two Dall's porpoises from Alaska had fed only on capelin. Brown and Norris (1956) mentioned anchovy as a food item of the Dall's porpoise. An adult porpoise taken in southern California waters had eaten at least 14 Pacific hake, 2 jackmackerel, and 13 cephalopods (Norris and Prescott 1961). These authors also noted the porpoise circling amid schools of sauries, probably feeding. Fiscus and Niggol (1965) observed Dall's porpoises off the north coast and collected five specimens off Cape Mendocino, California. Three females and one of the males had only squid beaks in their stomachs; the stomach of the other male was empty.

The Dall's porpoise is present in Monterey Bay all year. Stomach samples, examined each month, indicated that Pacific hake, rockfish, and squid are important food items. Loeb (1972) examined 25 stomachs of Dall's porpoise from Monterey Bay and found Pacific hake in 23, squid in 16. Most of the cephalopods present were *Loligo*, with lesser numbers of *Abraliopsis*, *Gonatus*, *Onychoteuthis*, and *Octopus*. Pacific hake, juvenile rockfish, and squid made up 93 percent of the total diet of the Dall's porpoise from Monterey Bay (Table 5 in Loeb 1972).

On 28 June 1973, an immature female Dall's porpoise was found on the beach north of the University of California Marine Station at Bodega Bay. Presumably this animal (REJ 670, 102 cm total length) was dependent on its mother for nourishment, although no milk was noted in its stomach.

I examined four adult Dall's porpoises (2 males, 2 females), and only two had identifiable food remains. One (REJ 674) had 61 Pacific hake otoliths representing 31 fish in its stomach, and the other (CAS 2335) contained 6 juvenile Pacific tomcod. The two other porpoises had empty stomachs (CAS 2384, REJ 678).

Loeb (1972) did not mention Pacific tomcod as a dietary item from Dall's porpoises but did note a wide variety of fishes (15 species) eaten by Dall's porpoises from Monterey Bay. Pacific hake have been reported as important food for Dall's porpoise (Scheffer 1953; Norris and Prescott 1961; Fiscus and Niggol 1965; Loeb 1972). The hakelike fish (*Laemonema*, family Moridae) occurs in the diet of Dall's porpoise from Japanese waters (Wilke and Nicholson 1958).

No cephalopods were found in any of the five Dall's porpoise stomachs from my northern California sample.

Delphinus delphis, Pacific common dolphin

Common dolphins seldom are sighted north of the California-Oregon border and are rare beyond the 100-fathom (183-m) line (National Oceanic and Atmospheric Administration 1974). Four *Delphinus* stomachs collected off California contained fish and cephalopods (Fiscus and Niggol 1965). One female had unidentified fish otoliths and another stomach contained (by volume) 60 percent squid, 25 percent saury, and 15 percent northern anchovy. One male dolphin taken at sea contained 90 percent *Loligo* and 10 percent saury. Another stomach contained 60 percent lanternfish (Myctophidae) and 40 percent squid (*Gonatus* sp., 20 percent; *Onychoteuthis* sp., 10 percent; unidentified squid, 10 percent) (Fiscus and Niggol 1965).

Observations in California waters indicate that common dolphins are present in inshore waters throughout the year (Norris and Prescott 1961). The major foods seem to be sardines, anchovies, sauries, small bonito, and squid (Norris and Prescott 1961).

Schmidt (1923) removed 15,191 otoliths from the stomach of one *Delphinus*. These otoliths represented five species of small fish (7596 individuals). Frost (1924) looked at 4338 of these same otoliths and identified six species in three families. Myctophid fish accounted for 4324 of these 4338 otoliths. The fishes represented probably did not constitute a "full" meal for this dolphin (Fitch and Brownell 1968).

Many common dolphins stranded in southern California had empty stomachs (Robert Brownell, Jr., Smithsonian Institution, pers. comm. [1970]). Fitch and Brownell (1968) examined two which had 133 and 119 otoliths. Anchovy remains (141 sagittae) were the most abundant. One dolphin had eaten 63 fishes representing six families. Anchovy, myctophids, and saury were represented in the other common dolphin examined. These authors speculated that both *Lagenorhynchus* and *Delphinus* feed on mesopelagic fish at depths exceeding 120 m (Fitch and Brownell 1968).

The Pacific common dolphin (CAS 2340) I examined had 11 otoliths assigned to two species; medusafish (*Icichthys lockingtoni*) and an osmerid. This specimen also had four *Loligo* beaks. Medusafish are most abundant around jellyfish and in the upper 150 ft (ca. 46 m) of the ocean (John Fitch, California Dept. of Fish and Game, pers. comm. [1973]). Apparently this dolphin had fed near the surface.

Lagenorhynchus obliquidens,
Pacific white-sided dolphin

This dolphin has received careful attention from west coast biologists during the last 25 years (Scheffer 1950b, 1953; Brown and Norris 1956; Houck 1961; Norris and Prescott 1961). These authors reported sardine, Pacific herring, salmon, northern anchovy, "scad" (=jackmackerel), Pacific saury, squid, and jellyfish remnants as food items (Table 8).

Large feeding aggregations of California sea lions, elephant seals, common dolphins, and Pacific white-sided dolphins have been observed by various authors (Norris and Prescott 1961; Fiscus and Niggol 1965). Mixed schools of common and white-sided dolphins have been noted

TABLE 8. STOMACH CONTENTS OF *Lagenorhynchus obliquidens* FROM THE WEST COAST OF NORTH AMERICA (CALIFORNIA).

Locality	Sex	Date	Source	Type of contents
w Trinidad	F	11 Sep 1958	(3)	Pacific sauries, "scad"
Humboldt Co.	M	26 Dec. 1968	(6)	Pacific sanddab, Pacific hake, eulachon, squid
Marin Co.	F	9 Feb. 1970	(6)	no ID (fish)
San Mateo Co.	M	29 Sep. 1972	(6)	shortbelly rockfish, northern anchovy, plainfin midshipman
San Mateo Co.	F	6 May 1973	(6)	Pacific hake, jackmackerel
w Santa Cruz	M	4 Mar. 1959	(4)	trace squid
w Santa Cruz	F	5 Mar. 1959	(4)	northern anchovy, Pacific hake, squid
Monterey Co.	F	21 Apr. 1973	(6)	night smelt
Monterey Co.	F	29 May 1970	(6)	squid, octopus
w Pt. Piedras	F	27 Feb. 1959	(4)	northern anchovy, squid
NW Morro Bay	M	22 Feb. 1959	(4)	northern anchovy, Pacific hake, squid
w Morro Bay	F	14 Feb. 1959	(4)	trace squid
s Anacapa I.	M	27 Feb. 1952	(1)	jellyfish, squid
Santa Monica	?	22 Aug. 1963	(5)	Pacific hake, northern anchovy, white seaperch, cephalopods
s San Pedro	F	6 June 1953	(2)	anchovies, squid
Long beach	F	21 Aug. 1967	(5)	northern anchovy, Pacific hake, cephalopods, queenfish

(1) Scheffer 1953.
(2) Brown and Norris 1956.
(3) Houck 1961.
(4) Fiscus and Niggol 1965.
(5) Fitch and Brownell 1968.
(6) Current study 1973.

off southern California where the white-sided dolphins are common, but north of San Francisco only small groups of *Lagenorhynchus* have been seen (Fiscus and Niggol 1965).

In southern California waters, white-sided dolphins have a distinct seasonal movement during the summer and fall which correlates with a shift from anchovies and squids as a principal food to the offshore schools of Pacific saury. This conclusion is from field observations only and from one stomach analysis (Brown and Norris 1956). No seasonal migration of white-sided dolphins has been observed in northern California. A migration of white-sided dolphins to northern California may correlate with oceanic current shifts and/or fish migratory patterns.

Pacific sanddab, eulachon, night smelt, shortbelly rockfish, and plainfin midshipman can now be added to the known species of food fishes reported from white-sided dolphins. I recovered 89 otoliths, only 3 of which represent open-water fishes. The great number of otoliths from inshore schooling fishes (Table 6) tends to indicate that this dolphin eats abundant, small fishes (osmerids, midshipman, and juvenile rockfish).

The fact that white-sided dolphins feed on five kinds of cephalopods gives the impression that these invertebrates are a major food resource (Tables 5 and 9). My data indicate that the white-sided dolphin apparently is not dependent on cephalopods in northern California; only three of seven stomachs had molluscan remains. One dolphin (REJ 625) contained 147 of the 155 cephalopod beaks found.

Grampus griseus, Risso's dolphin

Until recent stranding records were published (Orr 1966; Paul 1968; Stroud 1968; Hatler 1971) this dolphin was known only from the type of *Grampus stearnsii* (Dall) collected at Monterey Bay in 1873. All four previous specimens reported were males, and only two contained identifiable food remains. Orr (1966) reported a Risso's dolphin from San Mateo County that contained two pairs of beaks from the squid *Dosidicus gigas*. Stroud (1968) listed seven categories of cephalopod beaks from a male Risso's dolphin recovered in Washington: *Onychoteuthis* (1), *Octopodoteuthis* (1), *Chiroteuthis* (16), *Gonatus* (4), Gonatidae—form A (7), Gonatidae—form B (13), and unidentified beaks (2). No fishes have been found in any Risso's dolphin.

I examined a single specimen at Southeast Farallon Island on 20 May 1973. All standard measurements (275 cm total length) were taken, and the reproductive tract, blood sample, and complete skeleton were saved. No parasites were discovered, but a goose-neck barnacle (*Pollicipes polymerus*) and a single hydroid (*Aglaophenia latirostris*) were in the stomach. Orr (1951) theorized that such material is swallowed incidentally as the animal thrashes close to shore. The barnacle and hydroid reported here were probably accidentally ingested. Both kinds of invertebrates are plentiful on the intertidal shores of the Farallon Islands. Hatler (1971) reported that plant material seems to be an "herbal remedy" in *Grampus*. Risso's dolphin is probably an invertebrate feeder like *Globicephala*, which eats only squid as reported by Sergeant and Fisher (1957). *Grampus* lack teeth in the upper jaw and may feed solely on soft invertebrates.

Kogia simus, Dwarf sperm whale

Brownell obtained three dwarf sperm whales from Japanese waters. Although a good comparative collection of Japanese fishes was lacking, Fitch and Brownell (1968) presented a table indicating that 18 different species of fish in 7 families were in the stomachs. Because two families (Macrouridae and Moridae) are inhabitants of deep water, these authors speculated that *Kogia* feeds 800 ft (244 m) or more beneath the surface. Other authors have stated that most specimens of *Kogia* had eaten cephalopods or pelagic crustaceans (National Oceanic and Atmospheric Administration 1974).

Scheffer and Slipp (1948) examined a male pygmy sperm whale specimen from Washington. It had 500 cc of nematodes and food fragments in its stomach; 11 eye lenses (including 5 from squid), 15 squid beaks, 21 otoliths of an unidentified fish, 1 crab limb, maxillary bones of 2 specimens of *Trichodon* (?), and fragments of shrimp *Pasiphaea*, *Pandalus*, *Pandalopsis*.

Kogia has a discontinuous distribution and is rather poorly known from the west coast. Few have been seen alive. Beach-cast specimens have provided material for anatomical, taxonomic, and distributional studies, but essentially nothing is known of its life history (Handley 1966).

Because of difficulty of identification prior to Handley's work (1966), most earlier literature could apply to either the pygmy sperm whale (*K. breviceps*) or the dwarf sperm whale. Only in recent studies can identification be trusted.

One *K. simus* recovered at Thorton Beach, San Mateo County, by the California Academy of Sciences (CAS 2382, male, 204 cm total length) contained 217 beaks representing 112 individuals of these families: Octopoteuthidae, Onychoteuthidae, Enoploteuthidae, Histioteuthidae, Gonatidae, Chiroteuthidae. In addition, a single pair of otoliths in its stomach was from a plainfin midshipman (*Porichthys*). This is the most northern record of *Kogia simus* along the west coast.

Discussion

Statements about marine-mammal diets frequently have been vague and misleading and give a false impression of the role these animals play in the marine ecosystem. Much more information is needed to understand predator-prey relationships in California waters (Steele 1970). California waters are rich in commercially important fishes, and these fishes are well studied. However, it is also pertinent to consider the stocks of noncommercial fishes and the dynamics of such populations. The distribution of both predator and prey, including the availability of the latter throughout the year, is of prime importance.

Adult marine mammals are usually migratory. The causes of these movements are largely unknown, but to some extent marine mammals respond to the seasonal abundance of food. The breeding cycle and its influence on food gathering have not been studied. The smaller whales are not associated with breeding rookeries as are pinnipeds. Cetaceans constantly search for prey and apparently lack the feeding-nursing cycle characteristically found in seals and sea lions.

The behavior and feeding techniques of all marine mammals are poorly documented. Escape strategies of prey species are not well known. The sheer abundance of smaller prey items allows the escape of some individuals from predators. Some fishes and invertebrates reduce predation upon themselves by camouflage or disguise. Armor and spines must also help some prey to reduce losses. Representatives of the following common families of fishes were completely absent from the marine mammal stom-

TABLE 9. STOMACH CONTENTS OF MARINE MAMMALS FOUND IN THIS STUDY (volume of dry fish bones, cephalopod identification, and miscellaneous items).

Field number	Fish bones (cc)	Cephalopod beaks Upper	Cephalopod beaks Lower	Identification
Zalophus				
68–40	950	–	–	—
317 LGB	400	–	–	—
647	35	2	3	*Octopus* sp.
660	4000	–	1	*Octopus* sp.
662	trace	3	–	*L. opalescens*
664	250	–	–	—
665	30	23	17	*L. opalescens*
666	5	–	–	—
667	trace	–	–	—
685	120	–	–	—
	1—*Polinices* shell, *Ulva*, eelgrass			
686	820	–	–	—
692	45	–	1	*Octopus* sp.
244	–	1	3	*L. opalescens*
Eumetopias				
69-8	600	–	1	*Chiroteuthis*
247	–	1	1	*L. opalescens*
249	–	6	7	*L. opalescens*
629	–	2	2	*Octopus* sp.
637	2850	2	2	*L. opalescens*
655	1—rock	–	1	*Onychoteuthis*
675	trace	–	–	—
677	5—rocks, trace	–	–	—
688	240	–	–	—
699	3200	–	1	*Octopus* sp.
Phoca				
69-24	trace	–	–	—
646	40	2	1	*Octopus* sp.
671	10	–	–	—
696	400	10	3	*Octopus* sp.
Callorhinus				
212	7—external fish isopods (*Riggia* ?)	–	–	—
243	–	7	7	*L. opalescens*
Delphinus				
CAS 2340	3	1	1	*L. opalescens*
Lagenorhynchus				
HSC 68-9	–	1	–	*Abraliopsis*
237	–	1	1	*Octopoteuthis*
		1	3	*L. opalescens*
		–	1	unknown Gonatidae
625	–	1	1	*Onychoteuthis*
		79	66	*L. opalescens*
		–	1	*Gonatus* sp.
652	trace	–	–	—
Phocoena				
241	–	9	7	*L. opalescens*
450	15	35	17	*L. opalescens*
653	–	8	5	*L. opalescens*
661	–	–	1	*L. opalescens*
673	75	1	1	*L. opalescens*

Table 9. Continued.

Field number	Fish bones cc	Cephalopod beaks Upper	Cephalopod beaks Lower	Identification
HSC 73-4	180	–	–	—
CAS 2384	–	2	3	*L. opalescens*
CAS 2385 (476)	trace	–	–	—
CAS 2392	–	35	36	*L. opalescens* plus 13 whole *Loligo*
CAS 2398	–	2	–	*Morotheuthis* sp.

achs examined in this study: Cottidae, Agonidae, Serranidae, Blenniidae, Clinidae, and Scombridae. These marine fishes are probably detected and perhaps discriminated as nonprey items. Possibly these fishes possess mechanisms to escape.

Sick or injured marine mammals will starve rapidly. Animals not showing obvious causes of death presumably were sick or injured and seldom had anything in their stomachs. Specimens showing evidence of violent sudden death had intact squid or fish. Others had only digestion-resistant items such as beaks or otoliths. One harbor porpoise (CAS 2390) had swallowed a 46-cm Pacific hake, the anterior end of which was partially digested. No food item in this study showed evidence of having been chewed or cut by the consumer. Field observations indicate that food is torn apart by much head shaking, and the teeth only aid in the capture and holding of prey. The lack of specialized forelimbs with which to manipulate food is evident in the swallowing of whole food.

Sexual dimorphism in the size of pinnipeds (Scheffer 1958) should be reflected in feeding rates and the species or size of prey selected, but no published data are available to substantiate this. However, such resource partitioning is shown between species (Table 6).

It appears that prey selection in marine mammals is specialized, and this conclusion is supported by the available data. Comparison of the food of *Phoca* with that of *Eumetopias* and *Zalophus* (Tables 1, 4, and 7) shows less dependence on pelagic fishes by *Phoca*. Perch, eelpout, and greenling (80 percent of the fish eaten by *Phoca*) are typically shallow-bottom species which live near rocky habitats. *Zalophus* characteristically feeds on Pacific hake, northern anchovy, and rockfish (93 percent of the fish). These open-water fishes are very abundant (Ahlstrom 1965; Bell (1971). *Eumetopias*, while also using Pacific hake and rockfish, relied more heavily on bottom-dwelling flatfish and cusk-eel (29.1 percent of the fish). *Octopus* was the only cephalopod found in the stomachs of harbor seals, although several other cephalopods are taken by California and northern sea lions (Table 9). Stomachs of *Eumetopias* frequently had stones in them (Table 9). Apparently there is some selection for these nonfood items by these sea lions. The depth of the sea at which these pinnipeds feed is unknown. All prey items normally eaten by *Eumetopias* inhabit water less than about 200 m deep. Thus *Zalophus* feeds on schooling fishes while *Eumetopias* feeds on bottom fishes (Table 6).

The mean feeding rate of small cetaceans as described by Sergeant (1969) is 10.8 percent of their body weight per day. No comparative information is available on feeding rates of juvenile individuals, nor have sexual or seasonal differences in feeding rates been published. Captive Arctic seals (*Cystophora*, *Pagophilus*) require food in amounts of 3–5 percent of their body weight per day in order to maintain good health (Blix et al. 1973). Daily food consumption of fur seals (10 percent of body weight), northern sea lion (4 percent of body weight), and harbor seal (11 percent of body weight) are recorded on field-collected specimens by Spalding (1964). These data do not include information on body size, reproductive state, or activity factors which influence the food consumption of these pinnipeds.

The smaller odontocetes fed on more cephalopods (17 percent of the diet) than did the pinnipeds (5 percent) (Tables 5 and 9). The diet of the sea lions in this study was 95 percent fish, compared with 83 percent in the cetaceans.

Phocoena fed heavily on rockfish, anchovy, and juvenile Pacific hake. Most of these fishes are semi-pelagic, small, and probably occur near the surface. The recoveries of harbor porpoises were limited to the period April to September and therefore do not reflect a year-round dietary sample. These porpoises prey extensively on *Loligo*, which is present throughout the year.

Lagenorhynchus associates with many other species of marine animals and perhaps feeds on a wide variety of prey. Data from this study (Table 8) indicate that white-sided dolphins are generalized feeders. Osmerids and midshipmen, representing two distinct habitats (inshore schooling and bottom-dwelling), were major food items. Although midshipmen live from the intertidal regions to a depth of 170 fathoms (about 311 m), they also leave the bottom in search of food (Fitch and Lavenberg 1971). We do not know where or when this fish is eaten, but it is an important component in the diets of all marine mammals studied.

Acknowledgments

So many individuals have contributed to this study that it is impractical to list them all. The telephone calls from federal, state, and county officials and other interested persons reporting carcasses are deeply appreciated. Personnel at the Point Reyes Bird Observatory deserve special thanks. The facilities of these institutions were used: California Academy of Sciences; Museum of Vertebrate Zoology, University of California, Berkeley; Humboldt State University.

Personnel of each institution extended aid, especially my dissertation committee at Humboldt State University, chaired by Dr. W. J. Houck. The patience showed by the manuscript reviewers is appreciated; thank you, Drs. S. Harris, J. Waters, and W. Z. Lidicker, Jr. The assistance of Mr. John E. Fitch, Research Director, State Fisheries Laboratory, California Department of Fish and Game, was essential for the identification of fish otoliths. Mr. Clifford H. Fiscus, National Marine Fisheries Service, Seattle, Washington, aided with the identification of the cephalopod beaks.

My able field assistants located as many old carcasses as I did. Thanks, Pica, Chepen, Dusty, and Ginger. And lastly, the support of Lise made all the tasks easier.

Literature Cited

Ahlstrom, E. H. 1965. Kinds and abundance of fishes in the California Current region based on egg and larval survey. Calif. COFI Prog. Rep. 10:31–37.

Anderson, H. 1960. Sea lions—creatures of controversy. Calif. Senate Fact Finding Committee on Natural Resources. Fort Bragg, California. 14 p.

Anonymous. 1901. Sea lions as fish destroyers. For. Stream 56(22):428.

Anonymous ("Steelhead," pseudonym). 1901. Food of sea lions. For. Stream 56(26):507–508.

Bartholomew, G. A. 1967. Seal and sea lion populations of the California Islands. Pp. 229–244 *in* R. N. Philbrick (ed.), Proc. Symp. on the Biology of the California Islands. Santa Barbara Botanic Garden, Santa Barbara.

Bell, R. R. 1971. California marine fish landings for 1970. Calif. Dep. Fish Game Fish Bull. 154. 50 p.

Bigg, M. A. 1969. The harbor seal in British Columbia. Fish. Res. Bd. Canada Bull. 172. 33 p.

Blix, A. S., J. A. Iverson, and A. Pasche. 1973. On the feeding and health of young hooded seals (*Cystophora cristata*) and harp seals (*Pagophilus groenlandicus*) in captivity. Norw. J. Zool. 21:55–58.

Bonnot, P. 1928. Report on the seals and sea lions of California. Calif. Dep. Fish Game Fish Bull. 14. 61 p.

———. 1932a. Food habits of the Pacific harbor seal. Calif. Fish Game 18:98

———. 1932b. A note on the fishing of the California sea lion. Calif. Fish Game 18:98–99.

———. 1951. The sea lions, seals, and sea otter of the California coast. Calif. Fish Game 37:371–389.

Briggs, K. T., and C. W. Davis. 1972. A study of predation by sea lions on salmon in Monterey Bay. Calif. Fish Game 58:37–43.

Brown, D. H., and K. S. Norris. 1956. Observations of captive and wild cetaceans. J. Mammal. 37:311–326.

Brownell, R. L., Jr. 1964. Observations of odontocetes in central California waters. Norsk Hvalfangst-Tidende 53(3):60–66.

California Division of Fish and Game. 1927. What do sea lions eat? Calif. Fish Game 13:119–120.

Clarke, M. R. 1962. The identification of cephalopod 'beaks' and the relationship between beak size and total body weight. Bull. Brit. Mus. (Nat. Hist.) Zool. 8(10):419–480.

Clemens, W. A., and G. V. Wilby. 1933. Food of the fur seal off the coast of British Columbia. J. Mammal. 14:43–46.

———, and ———. 1961. Fishes of the Pacific coast of Canada. Second ed. Fish. Res. Bd. Canada Bull. 68. 443 p.

Clothier, C. R. 1950. A key to some southern California fishes based on vertebral characters. Calif. Fish Game Fish Bull. 79. 83 p.

Cowan, I. M. 1944. The Dall porpoise, *Phocoenoides dalli* (True), of the northern Pacific Ocean. J. Mammal. 25:295–306.

Cox, K. W. 1963. Egg-cases of some elasmobranchs and a cyclostome from Californian waters. Calif. Fish Game 49:271–289.

Daugherty, A. E. 1972. Marine mammals of California. Second ed. Dept. Fish and Game, Sacramento, California. 87 p.

Dyche, L. L. 1901 Notes on the food habits of California sea lions. [Manuscript *in* C. H. Merriam files Mus. Vert. Zool. Univ. Calif., Berkeley. 6 p.]

———. 1903. Notes on the food habits of California sea lions. *Zalophus californianus* Lesson. Trans. Kansas Acad. Sci. 18:179–182.

Evans, W. E., and J. Bastian. 1969. Marine mammal communication: social and ecological factors. Pp. 425–475 *in* H. T. Andersen. The biology of marine mammals. Academic Press, New York.

Evermann, B. W. 1921. The Año Nuevo Steller sea lion rookery. J. Mammal. 2:16–19.

———, and G D. Hanna. 1925. The Steller sea lion rookery on Año Nuevo Island, California in 1924. J. Mammal. 6:96–99.

Fink, B. D. 1959. Observation of porpoise predation on a school of Pacific sardines. Calif. Fish Game 45:216–217.

Fiscus, C. H., and G. A. Baines. 1966. Food and feeding behavior of Steller and California sea lions. J. Mammal. 47:195–200.

———, and K. Niggol. 1965. Observations of cetaceans off California, Oregon, and Washington. U.S. Fish Wild. Serv. Spec. Sci. Rep. Fish. 498. 27 p.

Fitch, J. E., and R. L. Brownell, Jr. 1968. Fish otoliths in cetacean stomachs and their importance in interpreting feeding habits. J. Fish. Res. Bd. Canada 25:2561–2574.

———, and R. J. Lavenberg. 1971. Marine food and game fishes of California. California Natural History Guides 28. Univ. Calif. Press, Berkeley and Los Angeles. 179 p.

Freiburg, R. E., and P. C. Dumas. 1954. The elephant seal (*Mirounga angustirostris*) in Oregon. J. Mammal. 35:129.

Frey, H. W. (ed.). 1971. California's living marine resources and their utilization. Calif. Dept. Fish and Game. Sacramento, California. 148 p.

Frost, G. A. 1924. Fish otoliths from the stomach of a porpoise. Nature 113:310.

Fry, D. H., Jr. 1939. A winter influx of sea lions from Lower California. Calif. Fish Game 25:245–250.

Hall, E. R., and J. W. Bee. 1954. Occurrence of the harbor porpoise at Point Barrow, Alaska. J. Mammal. 35:122–123.

Handley, C. O., Jr. 1966. A synopsis of the genus *Kogia* (Pygmy Sperm Whales). Pp. 62–69 *in* K. S. Norris (ed.). Whales, porpoises, and dolphins. Univ. Calif. Press, Berkeley and Los Angeles.

Hanna, G D. 1951. Alaska fur seals, *Callorhinus ursinus*, observed off San Francisco Bay, California. J. Mammal. 32:364–365.

Harrison, R. J. (ed.). 1972. Functional anatomy of marine mammals. Vol. 1. Academic Press, London and New York. 451 p.

———, F. R. Johnson, and B. A. Young. 1970. The oesophagus and stomach of dolphins (*Tursiops, Delphinus, Stenella*). J. Zool. 160:377–390.

Hatler, D. F. 1971. A Canadian specimen of Risso's dolphin. Canadian Field-Nat. 85:188–189.

Hedgpeth, J. W. 1944. Sea lions. Nat. Mag. 37(8):443–445.

Houck, W. J. 1961. Notes on the Pacific striped porpoise. J. Mammal. 42:107.

Hubbs, C. L., W. I. Follett, and L. J. Dempster. 1979. List of the fishes of California. Occas. Pap. Calif. Acad. Sci. 133. 51 p.

Huey, L. M. 1925. Late information on the Guadalupe Island elephant seal herd. J. Mammal. 6:126–127.

———. 1930. Capture of an elephant seal off San Diego, California, with notes on stomach contents J. Mammal. 11:229–231.

Imler, R. H., and H. R. Sarber. 1947. Harbor seals and sea lions in Alaska. U.S. Fish Wild. Serv. Spec. Sci. Rep. 28. 23 p.

Iverson, I. L. K., and L. Pinkas. 1971. A pictorial guide to beaks of certain eastern Pacific cephalopods. Calif. Fish Game Fish Bull. 152:83–105.

Jameson, R. J., and K. W. Kenyon. 1978. Prey of sea lions in the Rogue River, Oregon. J. Mammal. 58:672.

Kenyon, K. W. 1952a. Diving depths of the Steller sea lion and Alaskan fur seal J. Mammal. 33:245–246.

———. 1952b. The Steller sea lion. Pac. Discovery 5(4):4–13.

———. 1965. Food of harbor seals at Amchitka Island, Alaska. J. Mammal. 46:103–104.

———, and V. B. Scheffer. 1955. The seals, sea lions, and sea otter of the Pacific coast. U.S. Fish Wild. Serv. Circ. 32. 34 p.

King, J. E. 1964. Seals of the world. Brit. Mus. (Nat. Hist.) London. 154 p.

Loeb, V. J. 1972. A study on the distribution and feeding habits of the Dall porpoise in Monterey Bay, California. Unpublished Master's Thesis, San Jose State College. 62 p.

Lustig, B. L. 1948. Sight records of Dall porpoises off the Channel Islands, California. J. Mammal. 29:183.

Marine Mammal Biological Laboratory. 1969. Fur seal investigations, 1966. U.S. Fish Wild. Serv. Spec. Sci. Rep. Fish. 584. 123 p.

Mate, B. R. 1973. Population kinetics and related ecology of the northern sea lion, *Eumetopias jubatus*, and the California sea lion, *Zalophus californianus*, along the Oregon coast. Ph.D. Thesis. Univ. of Oregon. 94 p.

Mathisen, O. A. 1959. Studies on Steller sea lion (*Eumetopias jubata*) in Alaska. Trans. N. Am. Wildl. Res. Conf. 24:346–356.

———, R. T. Baade, and R. J. Lopp. 1962. Breeding habits, growth, and stomach contents of the Steller sea lion in Alaska. J. Mammal. 43:469–477.

Merriam, C. H. 1901a. Food of sea lions. Science 8:777–779.

———. 1901b. Food of sea lions. For. Stream 56(21):428.

Miller, D. J., and R. N. Lea. 1972. Guide to the coastal marine fishes of California. Calif. Fish Game Fish Bull. 157:1–235.

Morejohn, G. V., and D. M. Baltz. 1970. Contents of the stomach of an elephant seal. J. Mammal. 51:173–174.

National Oceanic and Atmospheric Administration. 1974. Report of the Secretary of Commerce. Administration of the Marine Mammal Protection Act of 1972. Federal Register 39:23896–23932.

Nelson, O. M., and H. A. Larkins. 1970. Distribution and biology of Pacific hake: a synopsis. Pp. 23–24 *in* Pacific hake. U.S. Fish Wildl. Serv. Circ. 332.

Newcombe, C. F., W. H. Greenwood, and C. M. Fraser. 1918. The sea-lion question in British Columbia. Contrib. Canadian Biol. Sessional Paper 38a. 39 p.

———, and W. A. Newcombe. 1914. Sea-lions on the coast of British Columbia. Rep. Comm. Fish. B.C. for 1913:131–145.

Norris, K. S. (ed.). 1961. Committee on marine mammals. Standardized methods for measuring the recording data on the smaller cetaceans. J. Mammal. 42:471–476.

———, and J. H. Prescott. 1961. Observations on Pacific cetaceans of Californian and Mexican waters. Univ. Calif. Publ. Zool. 63:291–401.

Odell, D. K. 1971. Censuses of pinnipeds breeding on the California Channel Islands. J. Mammal. 52:187–190.

Orr, R. T. 1937. A porpoise chokes on a shark. J. Mammal. 18:370.

———. 1951. Cetacean records from the Pacific coast of North America. Wasmann J. Biol. 9(2):147–148.

———. 1966. Risso's dolphin on the Pacific coast of North America. J. Mammal. 47:341–343.

———. 1972. Marine mammals of California. Calif. Nat. Hist. Guides 29. Univ. Calif. Press, Berkeley and Los Angeles. 64 p.

———, and T. C. Poulter. 1965. The pinniped population of Año Nuevo Island, California. Proc. Calif. Acad. Sci., ser. 4, 32:377–404.

———, and ———. 1967. Some observations on reproduction, growth, and social behavior in the Steller sea lion. Proc. Calif. Acad. Sci., ser. 4, 35:193–226.

Paul, J. R. 1968. Risso's dolphin, *Grampus griseus*, in the Gulf of Mexico. J. Mammal. 49:746–748.

Perrin, W. F. 1970. The problem of porpoise mortality in the U. S. tropical tuna fishery. Pp. 45–48 *in* Proceedings 6th Annual Conference on Biological Sonar and Diving Mammals. Stanford Res. Inst., Menlo Park, Calif.

———, R. R. Warner, C. H. Fiscus, and D. B. Holts. 1973. Stomach contents of porpoise, *Stenella* spp., and yellowfin tuna, *Thunnus albacares*, in mixed-species aggregations. U.S. Natl. Mar. Fish. Serv. Fish. Bull. 71:1077–1092.

Peterson, R. S., and G. A. Bartholomew. 1967. The natural history and behavior of the California sea lion. Am. Soc. Mammal. Spec. Publ. no. 1. 79 p.

———, and B. J. LeBoeuf. 1969. Population study of seals and sea lions. Trans. N. Am. Wildl. Res. Conf. 34:74–79

Pike, G. C. 1958. Food of the Northern sea lion. Pp. 18–20 *in* Prog. Rep. 112, Fish. Res. Bd. Canada Biol. Sta. Nanaimo, B.C.

———, and I. B. MacAskie. 1969. Marine mammals of British Columbia. Fish. Res. Bd. Canada Bull. 171. 54 p.

Rae, B. B. 1965. The food of the common porpoise (*Phocoena phocoena*). J. Zool. (Proc. Zool. Soc. London) 146:114–122.

Redding, B. R., S. R. Throckmorton, and J. D. Farwell. 1875. P. 13 *in* Report of the Commissioners of Fisheries of the State of California, 1874–1875. Sacramento.

Ridgway, S. H. (ed.). 1972. Mammals of the sea: biology and medicine. Charles C Thomas, Springfield, Illinois, 812 p.

Robins, C. R., R. M. Bailey, C. E. Bond, J. R. Brookes, E. A. Lachner, R. N. Lea, and W. B. Scott. 1980. A list of common and scientific names of fishes from the United States and Canada (Fourth edition). Am. Fish. Soc. Spec. Publ. 12. 174 p.

Roedel, P. M. 1953. Common ocean fishes of the California coast. Calif. Fish Game Fish Bull. 91. 184 p.

Rowley, J. 1929. Life history of the sea lions of the California coast. J. Mammal. 10:1–36.

Rutter, C., R. E. Snodgrass, and E. C. Starks. 1904. Report on the sea lion investigation. Pp. 116–119 *in* Hugh M. Smith. Report on inquiry respecting food-fishes and fishing-grounds. Rep. U.S. Comm. Fish Fish. Part 18.

Ryder, R. A. 1957. Avian-pinniped feeding associations. Condor 59:68–69.

Scammon, C. M. 1874. The marine mammals of the northwestern coast of North America, described and illustrated; together with an account of the American whale-fishery. John H. Carmany and Co., San Francisco. 319 p. [Reprinted by Dover Co., New York. 1968.]

Scheffer, T. H. 1928. Precarious status of seal and sea-lion on our northwest coast. J. Mammal. 9:10–16.

———, and C. C. Sperry. 1931. Food habits of the Pacific harbor seal, *Phoca richardii*. J. Mammal. 12:214–226.

Scheffer, V. B. 1950a. The food of the Alaska fur seal. U.S. Fish Wild. Serv. Wild. Leaflet 329. 16 p.

———. 1950b. The striped dolphin, *Lagenorhynchus obliquidens* (Gill 1865), on the coast of North America. Am. Midl. Nat. 44:750–758.

———. 1953. Measurements and stomach contents of eleven delphinids from Northeast Pacific. Murrelet 34(2):27–30.

———. 1958. Seals, sea lions, and walruses, a review of the pinnipedia. Stanford Univ. Press, Stanford, California. 179 p.

——— (ed.). 1967. Committee on marine mammals. Standard measurements of seals J. Mammal. 48:459–462.

———, and J. A. Neff. 1948. Food of California sea-lions. J. Mammal. 29:67–68.

———, and J. W. Slipp. 1944. The harbor seal in Washington State. Am. Midl. Nat. 32:373–416.

———, and ———. 1948. The whales and dolphins of Washington State, with a key to the cetaceans of the west coast of North America. Am. Midl. Nat. 39:257–337.

Schmidt, J. 1923. Consumption of fish by a porpoise. Nature 112:902.

Schultz, L. P., and A. M. Rafn. 1936. Stomach contents of fur seals taken off the coast of Washington. J. Mammal. 17:13–15.

Seed, A. (ed.). 1972. Seals, sea lions, and walruses in eastern North Pacific and Arctic waters. Pacific Search, Seattle. 40 p.

Sergeant, D. E. 1968. Feeding ecology of marine mammals. Pp. 89–96 *in* Proc. 2nd Symposium on Disease and Husbandry of Aquatic Mammals. Marineland Florida Res. Lab.

———. 1969. Feeding rates of cetacea. Fiskeridir Skr. Ser. Havunders. 15(3):246–258.

———, and H. D. Fisher. 1957. The smaller cetacea of eastern Canadian waters. J. Fish. Res. Bd. Canada 14:83–115.

Slijper, E. J. 1962. Whales, translated by A. J. Pomerans. Basic Books, New York. 475 p.

Smith, G. J. D., and D. E. Gaskin. 1974. The diet of harbor porpoises [*Phoecoena phocoena* (L)] in coastal waters of eastern Canada, with special reference to the Bay of Fundy. Canadian J. Zool. 52:777–782.

Spalding, D. J. 1964. Comparative feeding habits of the fur seal, sea lion, and harbour seal on the British Columbia coast. Fish. Res. Bd. Canada Bull. 146. 52 p.

Starks, E. C. 1918. The sea lions of California. Am. Mus. J. 18(3):226–237.

Steele, J. H. (ed.). 1970. Marine food chains. Univ. Calif. Press, Berkeley and Los Angeles. 552 p.

Stroud, R. K. 1968. Risso dolphin in Washington State. J. Mammal. 49:347–348.

Thorsteinson, F. V., and C. J. Lensink. 1962. Biological observations of Steller sea lions taken during an experimental harvest. J. Wildl. Manage. 26:353–359.

Tomilin, A. C. 1957. Mammals of U.S.S.R. and adjacent countries. Vol. 9. Cetaceans. Translated from Russian (Israel program for scientific translation, Jerusalem. 1967). 717 p.

Townsend, C. H. 1918. Sea lions and the fishery industries. N.Y. Zool. Soc. Bull. 21:1679–1682.

———. 1919. The utilization of the sea lion. N.Y. Zool. Soc. Bull. 22:32–33.

Wilke, F. 1957. Food of sea otters and harbor seals at Amchitka Island. J. Wildl. Manage. 21:241–242.

———, and K. W. Kenyon. 1952. Notes on the food of fur seal, sea-lion, and harbor porpoise. J. Wildl. Manage. 16:396–397.

———, and ———. 1957. The food of fur seals in the eastern Bering Sea. J. Wildl. Manage. 21:237–238.

———, and A. J. Nicholson. 1958. Food of porpoises in waters off Japan. J. Mammal. 39:441–443.

CALIFORNIA ACADEMY OF SCIENCES
Golden Gate Park
San Francisco, California 94118